THE EARLY WEIGHTS AND MEASURES OF MANKIND



GENERAL SIR CHARLES WARREN

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OF MANKIND

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BY

GENERAL SIR CHARLES WARREN

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PUBLISHED BY THE

COMMITTEE OF THE PALESTINE EXPLORATION FUND

2, HINDE STREET, MANCHESTER SQUARE

LONDON, W.

1913

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TO THE MEMORY OF

THE MUCH ESTEEMED AND VALUED FRIEND OF A LIFETIME,

CLAUDE REIGNIER CONDER, LL.D.,

Colonel Royal Engineers,

WITH WHOM FOR MANY YEARS I HAD THE PRIVILEGE OF CORRESPONDING ON THE SUBJECT OF THE MIGRATION OF RACES, AND THE DISTRIBUTION OF WEIGHTS AND MEASURES OF THE WORLD,

AND ON WHOSE JUDGMENT CONCERNING THE RACES OF ASIA MINOR AND BABYLONIA, AS RECORDED IN HIS NUMEROUS WORKS, I SET THE HIGHEST VALUE

PREFACE

In putting this manual of "Early Weights and Measures of Mankind" before the public, I most gratefully acknowledge the obligation I am under to Professor Flinders Petrie for his publication of that remarkable book, "Inductive Metrology," containing records of all the building cubits of the world.

I have had occasion constantly to refer to this work, and it is in a great measure owing to this storehouse of accurate information, brought together by Professor Petrie, that I have been enabled to bring my work to a successful conclusion.

CHARLES WARREN.

The Oaks, Westbere, Canterbury,
August 1, 1913.

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WORKS REFERRED TO OR CONSULTED

The Roman Foot and Denarius	J. Greaves	1647
Ancient Coins, Weights and Measures	John Arbuthnot	1754
Connexion of Coins: Roman, Saxon and English	J. Clark	1767
History of Jewish Coinage	F. W. Madden	1864
Ancient Measures: Attic, Roman, Jewish	Bishop Hooper	1721
Fasti Hellenici	H. Fynes Clinton	1830
The Universal Cambists	P. Kelly	1821
Asiatic Researches, vol. v.: Indian Weights and Measures	H. T. Colebrooke	1807
Inductive Metrology	W. M. Flinders Petrie	1877
The Pyramid of Gizah	W. M. Flinders Petrie	1883
Robertson's Historical Essays: Standards of the Past	E. W. Robertson	1872
The Great Pyramid	J. Taylor	1854
Tables of Weights and Measures	G. Buchanan	1829
Prinsep's Indian Antiquities	E. Thomas	1858
The Chronicles of the Pathan Kings of Delhi	E. Thomas	1879
Numismata Orientalia: Ancient Indian Weights	E. Thomas	1872
Our Inheritance in the Great Pyramid	C. Piazzi Smyth	1890
Our Weights and Measures	H. J. Chaney	1897
Greek and Roman Metrology	F. Hultsch	1882
Rude Stone Monuments	J. Fergusson	1872
Dictionary of Greek and Roman Antiquities: Weights and Measures	W. Smith	1873
Dictionary of the Bible: Weights and Measures: Money	W. Smith	1893
Dictionary of the Bible: Weights and Measures: Money. Babylonia	J. Hastings	1898
Murray's Bible Dictionary: Weights and Measures: Money	W. C. Piercy	1908
Measures: Past and Present	W. Donisthorpe	1894
Origin of Currency and Weight Standards	W. Ridgeway	1892
Arabic Weights and Measures	Silvestre de Sacy	1905
A Bushel of Corn	J. Stephen	1883
Men and Measures	E. Nicholson	1912

The Metric Systems of Ancient People .	V. Vazquez Queipo	1859
Cyclopædia of India	E. Balfour	1885
Encyclopædia Britannica. Eleventh Edition. Weights and Measures . . .	W. M. Flinders Petrie	1911
Dictionary of Islam	T. P. Hughes	1895
Ancient Weights and Measures . .	Hussey	1836
Palestine Exploration Fund Quarterly. From 1879.	—	
Reports of the Warden of the Standards, 1872-73	—	
Proceedings of the Society of Biblical Archæology: Weights and Measures . .	F. T. Griffiths	1890 1895

THE EARLY WEIGHTS AND MEASURES OF MANKIND

CHAPTER I

BINARY WEIGHTS AND MEASURES

When primitive man first began to realize the usefulness of weights and measures in his daily round, there was only one series of standards he could have recourse to, at all times and in all circumstances—a series of standards in terms of parts of his own body.

Throughout all ages, and amongst all people, even to the present day this is so. Witness the terms in use : Fingers (digits), nails, hands, fists, palms, spans, feet, forearms (ells and cubits), armstretches (fathom or orguia), and paces.

In all matters of our daily life, whether marketing or in the workshop, hunting or surveying, soldiering or navigating, we are accustomed to use parts of our body as our standard of measure, and constant practice enables us to do so with considerable accuracy, even when we have to refer our results to some fixed standard irrespective of the body.

The Natural Standard of Length.

The natural standard of length, used from the earliest times, is the height of a man, or the stretch of his arms from middle finger-tip to middle finger-tip, called a fathom (Greek, orguia).

This is the original basis of all linear measure, so that, assuming the height of a man in the early days to have ranged between 62 and 74 inches, we may be certain that the original unit standard of length lay between these limits. In process of time the fathom was superseded as the unit by the half fathom (double cubit), and later by the quarter fathom (the cubit), and

in still later times by the sixth fathom (the foot). In later times also the length of the fathom was fixed geometrically, but there was always kept up a relation, both in length and cubical content, to the original cubit, which was distinguished from others by the term "a cubit of a man." The cubit of a man must have varied with every tribe until a more constant standard was discovered in the use of seeds: Rati or Gunga, barley, wheat, etc.

The Standard of Weight—The Load.

The weight of the body does not vary evenly in proportion to the height, but yet it was the only standard available in the beginning.

Probably two bundles, together the weight of a man, balanced on either ends of a pole across the shoulder, were the first standards of weight, giving from about 60 to 80 pounds to each bundle.

When it became desirable to use small weights, mankind had recourse to the weights of seeds of various kinds: Wheat, barley, Keration, and the Rati or Gunga seed, the latter being the earliest in use, and eventually a relation was arrived at between a number of seeds and the weight of the standard bundle.

The Standard of Capacity.

The body gives no assistance in this matter, and a standard could only be arrived at by making use of a unit of length, forming the sides of a receptacle or box to contain a number of seeds or a volume of water equal to the weight of seeds.

The first measures used appear to have been cylinders of equal height and radius, and cubes.

It does not require any computation to show that a cylinder $\frac{1}{8}$ the height of a man, in height and radius, would hold from 60 to 80 pounds weight of water, because we know that the cylindrical bushel measure of to-day, holding 80 pounds weight of water, has a depth and radius of 8·9046 inches, giving 71·2 inches to the height of a man; the cubit of a man thus being 17·8 inches.

As measures of capacity increase or diminish by doubling or halving the height (and radius, with cylinder), the capacity increases or diminishes by a multiple of 8.

The System of Numbering adopted by Early Man.

Before mankind occupied the Euphrates Valley and commenced their migrations over the world, they are assumed to have been located in tribes about Lake Van in Armenia, and to have possessed an old established civilization, so far as it went. They had some knowledge of the science of numbers, and they had weights and measures. Their system of numbering was at first binary. They could add and subtract in the progression 1, 2, 4, 8, 16, 32; consequently all their weights are based on doubling and halving. Subsequently they adopted the system of multiplying by fours, used by tribes in India at the present day (the Ganda system), and when measures of capacity were introduced they learnt by experience that by doubling the side of a cube or cylinder (radius also) they doubled the capacity three times in succession or eight times.

The Early Standard of Small Weight—The Rati, or Gunga.

From our own records and from ancient history we know that wheat and barley have been used in times past as a standard of small weight, barley being to wheat by weight as 4 : 3. So we have in Statute 51, Henry III., A.D. 1266, that the English penny should weigh "thirty-two grains of wheat, well dried, and gathered out of the middle of the ear"; this equals twenty-four barley grains or "one pennyweight."

In earlier times amongst all the civilized nations, Romans, Arabs, Assyrians, Babylonians, and Persians, barley corns and grains of wheat were standards of weight ("Origin of Currency and Weight Standards," Ridgeway, p. 170).

But it is in India that the original seed standard may still be found (the Rati or Gunga), not only in actual weight amongst the jewellers, but in the weights and measures tables, past and present, and in ancient records as far back as the Code of Manu.

The Rati or Gunga is the seed of the wild liquorice (*Abrus precatorius*), of which there are three varieties; that generally used is the red seed with a black spot. The advantage at present is that it is very uniform in size, and does not lose much weight by desiccation; but in early times, before corn growing

became general, it had the advantage of growing wild in the countries early peopled by man.

The Code of Manu, the earliest record of weights, gives tabulated accounts showing the seed weights of Rati used for silver, gold, and copper; although its records refer to later systems, the original numbering can still be observed. The numbers are, for silver, 2, 32, 320 Rati; for gold, 5, 80, 320, 3,200 Rati; and for copper, 80 Rati.

Weight of the Rati Seed.

The Rati is found over Syria, Asia Minor, Persia, and India, and from time immemorial it has been the standard used by the goldsmiths and money lenders.

A great number of trials have taken place as to its weight in different parts of India at various times during the past century (recorded by Mr. Thomas in *Numismata Orientalia*). The average weight adopted by Mr. Thomas is 1·75 G.T.; the standard I have adopted is 1·7044 G.T., or 1·6875 O.G.T. for the ancient rati, and 1·75 G.T. for the Moslem rati.

The connection with the Troy grain being 32 Rati = 48 Ancient Barley Grains = 54 Old Grains Troy = 54·54 Grains Troy. The Grain Troy having lost 1 per cent. since the Middle Ages. (See Note, end of Chapter I.)

The Rati seeds in the Museum at Kew (in 1874) average 1·5375 G.T., and an assortment of grains, obtained from Paris in 1906, averaged 1·57 G.T.

In six independent experiments in India during the past century the averages ranged from 1·8127 G.T. to 1·9120 G.T., and an early average by Sir W. Jones in 1790 was as low as 1·3125 G.T.

These various averages give almost as much variety as the stature of man in the same countries, but it would not have been a difficult matter for the jewellers in former days to have agreed to adhere to some special form or brand of Rati.

Weight of the Geometric Rati.

It is not probable that the average weight of the Rati would have coincided exactly with the standard weight subsequently fixed geometrically, from some fixed standard on the earth's surface, and therefore as time progressed the Rati grains used

as weights had to be picked out so as to conform to the geometric weights, and thus we are not dependent on the average weight of the actual Rati grain for our calculations.

Fortunately we are able to re-establish the actual weight of the Geometric Rati from weights now existing and from records with great certainty.

During the ages when mankind migrated from their original home to all parts of the world, they took their weights and measures with them, which have been preserved to the present day. They correspond with one another in a remarkable degree when due consideration is given to the origin in each case.

The following are the principal early weights found over Europe, Asia, and North Africa :

Name.	Rati.	Ancient Barley Grain.	O.G.T.	G.T.	Usual Weight, G.T.
The Ducat of Europe. Purana or Varaha of India	32	48	54	54·54	55–56
The Kat of Egypt, Karsha or Suvarna, India	80	120	135	136·35	134–6
The Shekel of Europe and the East ..	128	192	216	218·16	218
The Tower Pound, or Dharana, of Manu	3,200	4,800	5,400	—	5,400 in Europe and India; 5,600 in Moslem India
The Pint of Europe, Egypt, India ..	5,000 5,120	—	—	—	
The Hon or Pound, all the world over ..	4,000 4,096	—	6,750 6,912	—	7,000 Great Britain and Moslem India

There are also weights of less antiquity which contribute to establish the geometric weight of the Rati, such as the Roman pound of 5,184 O.G.T., the Attic pound 6,480 O.G.T., the Alexandrian Talent, the Moslem weights, the records of the measurements of the Great Pyramid and the seale of Gudea at Telloh, Babylonia.

The Original Weights on the Ganda, or (4) System.

The ancients at first, in their counting by numbers, were only able to add together similar numbers, and to subtract in the same manner ; doubling and halving, so that they were restricted to the numbers 1, 2, 4, 8, 16, 32, 64, etc.

In time they arrived at multiplying by 4 (the Ganda system), and eventually, from doubling the length of the side of a cube or a cylinder of equal height and radius, they got so far as to increase the capacity of a vessel eightfold, which for convenience will be called the 8^2 or (64) system.

This Ganda system is to be found in Indian records combined with the comparatively later systems (see Code of Manu), but at the present time it is only necessary to refer to the Ganda system so far as it affected the weights and measures of the earlier (64) system.

To the Ganda system appear to be due the very old weights of the world, the Varaha, or Ducat, the Shekel, the old ounce, and possibly the old half-pound.

The Rati has, in these pages, been accepted as the original weight and measure of ancient time, but for the Ganda system to be perfect it seems necessary to suppose that before the Rati came into use there was a seed or bean, double the weight of the Rati, used as a unit.

ORIGINAL UNITS.

1 Bean	=	2 Rati.	
4			
4	=	8 „	the unit of weight.
4			
16	=	32 „	the Varaha, or Ducat.
4			
64	=	128 „	the Shekel.
4			
256	=	512 „	the old ounce.
4			
1,024	=	2,048 „	the Seer of Central India.

THE BINARY SYSTEMS.

The Binary systems consist of:

1. The (4) or Ganda system, already mentioned; used for weights only.

2. The (64), or Octaval system, used for weights and capacities; the load was 64 Hon, or pounds of 4,096 Rati, and the fathom was divided into 64 parts.

3. The (80), or Octogintal system, was $1\frac{1}{4}$ of the (64) system; the bushel was 64 pints of 5,120 Rati, and the form was cylindrical, equal height, and radius; the fathom was divided into 80 parts, and the small weight standard was 80 Rati.

4. The (100), or Decimal system, reduced the (64) and (80) systems by about 2·4 per cent., so that the 4,096 and 5,120 Rati became respectively 4,000 and 5,000 Rati; the fathom was divided into 100 parts. This system was probably brought in when the quadrature of the circle took place, and when the geometric measures were fixed.

The Shape and Form of Weights and Measures.

We can only go back with any certainty to the time when measures and weights were fixed geometrically.

We may conjecture that the first development from an indefinite form was to the cylindrical shape, but so far as our records go the (64) system was cubic, and the (80) was cylindrical, the (64) to the (80) was as 4 : 5.

The Early Standard of Medium Weight—The Pound.

All nations have had their medium standards originally, about $\frac{1}{64}$ their half load.

The earliest medium standard was 16 shekels, or 2,048 Rati, under the Ganda system, and this standard can still be traced in Central India and in Europe.

Subsequently, under the (64) system this standard was doubled, and became the Hon of 4,096 Rati. It is the cube of 16 Rati, and occupies in bulk of seeds about 34 cubic inches; it is nearly the same weight as the Imperial pound of 7,000 G.T. Sixty-four Hon go to a cubic foot (1,728 C.I., or Cubic Inches).

Under the (80) system the pint of $1\frac{1}{4}$ Hon was established of 5,120 Rati, and the pound weight of 4,096 Rati filled the pint weighing 5,120 Rati weight of water.

Under the (100) system the pound and pint were each reduced by 2·4 per cent., so that they weighed respectively, when full of water, 4,000 and 5,000 Rati.

The (64) or Octaval System.

Progression by a multiple of 8 given for convenience. The original progression was probably by a multiple of 2 and then by 4.

Weight of Rati.	Name.
1	
8	
64	½ shekel
512	2 ounces, or 4 shekels
4,096	The original Hon weight
32,768	8 Hon weight
262,144	64 Hon weight, revised under (100) system to 256,000 Rati, when it became the weight of a cubic foot of water

There is no evidence that these measures were in the form of cubes; they may have been, at an early period, merely bags of seeds.

The (80) or Octogintal System—Weight by Water Introduced.

In this system the weight of water in a given receptacle, the Hon, weighing 4,096 Rati, is made the standard; whilst another receptacle, called a pint cylinder, and holding 5,120 geometric Rati weight of water, is the standard for dry measures (seeds). This gives a relation of Rati to water in weight. and bulk, of 64 : 80 and 80 : 64. This is entirely an arbitrary proportion, but is close to the truth, as the weight of corn to water, at the present day, bears the proportion 64 : 80 nearly.

Weight of (64) Vessel when Filled with Water.	Name.	Weight of (80) Vessel when Filled with Water.	Name.
Rati.		Rati.	
8		10	
64		80	Karsha weight
512		640	
4,096	Hon	5,120	Pint
32,768	8 Hon	40,960	Gallon
262,144	64 Hon	327,680	Bushel
2,097,152		2,621,440	Quarter

The Geometric Inch and Geometric Rati were fixed about this period after the diameter of the earth was estimated in inches.

Quadrature of the Circle (in the (80) Period).

Long before any great building operations took place in the plains of Babylonia early scientists were engaged in investigating the science of numbers, in *squaring the circle*. They sought to find a relation between the side of a square and the circumference of a circle, of equal area, which could be expressed in whole numbers and fractions easily dealt with.

They discovered several numbers which could thus be dealt with, each requiring a separate value to be given to π, some approaching nearer to the truth than others. One set of values, however, alone could be used for the purposes required, and they are given below :

$\frac{16}{5} = 3{\cdot}2$ probable original value of π.
$(\frac{5}{3}\frac{3}{6})^3 = \frac{25}{14} \times \frac{25}{14} = 3{\cdot}1909.$
$(\frac{44}{25} \times \frac{44}{25}) = 3{\cdot}09.$
$(\frac{25}{14} \times \frac{44}{25}) = \frac{22}{7} = 3{\cdot}1428.$

These values alone could be used for cylindrical and circular measure and calculation.

In working out the values of π they made a discovery of priceless value to them, which they subsequently recorded in the dimensions of the Great Pyramid of Gizeh.

They discovered that the circumferences of the two circles derived from any given square, the one containing the area of the square, the other equalling in length the four sides of the square, have the relation one to another of $\pi : 2\sqrt{\pi}$. On this their system of quadrating the circle was founded, and the number of units in the side of square selected was 44, or multiple of 44.

Taking a square of 44 units a side, they proceeded as follows :

1. The area $(44)^2$ is 1,936, and the circle with an area of 1,936 has a radius of 25, because $(\frac{44}{25})^2 \times (25)^2 = 1{,}936$.

2. The perimeter of the square on 44 equals $4 \times 44 = 176$, and taking this 176 as the circumference of a circle they arrived at the radius of 28, because $176 \times \frac{7}{22} \times \frac{1}{2} = 28$, and the area of the circle is 2,500, because $(\frac{25}{14})^2 \times (28)^2 = 2{,}500$.

Thus, in connecting the radius with the circumference, they could arrive at a close approximation to π, but in obtaining the area there was considerably more error. On this system, and on this value of π, this calculation of the ancients depended, so far as we know at present, and it will be found on investigation, in default of the decimal notation we now possess, it is the most simple method that can be devised for finding a relation between a square and circle.

The following are the values of the circles derived from square of 44, and the true values :

Name.	Circle Circumference.	Circle Radius.	Area.	Square Base.
Ancient *area* circle	$\frac{22}{7} \times 50$	25·0	1936·00	44·0
Circle with true values	$\pi \times 50$	25·0	1963·49	44·3
Ancient perimeter circle	— 176	28·0	2500 00	50·0
Circle with true values	$\sqrt{\pi} \times 100$	28·2	2500·00	50·0

If we multiply the area of the perimeter circle, 2,500 by 28, we have a cylinder 28 units in height and radius, with a volume of 70,000 units, and this volume, in the form of a cube or cylinder, was chosen as the basis of the weights and measures of the ancients under the new system.

It can be shown that $(\frac{53}{36})$ is the nearest convenient fraction to the cube root of π (3·1415926), therefore the side of a cube equal to 70,000 units is $\frac{53}{36} \times 28 = \frac{371}{9} = 41\frac{2}{9}$.

The circumference of area circle is $4 \times 39{\cdot}285$.

Measurement of an Arc of the Meridian and Evolution of the Inch and the Metre.

The ancients were thus possessed of a convenient method of comparing circular measure with square measure, and they had approached to a fixed standard of measure by means of the weight and dimensions of the Rati seed. They now needed a standard more rigidly accurate than seeds, and this they obtained by the measurement of an arc of the meridian in Babylonia.

This fixed standard they must have arrived at as early, at least, as the Fourth Egyptian Dynasty, because it is recorded both on the Great Pyramid and on the sitting statue of Gudea of Telloh.

Using the formula already given, they gave the earth a radius of 25 (10,000,000 units), and with π originally equal to $(\frac{4}{3})^4$, they found this circumference to be $4 \times 39{\cdot}5$ (10,000,000 units), the unit being the inch. In later times they used $\frac{22}{7}$ for π.

Thus the metre and inch were connected as at the present day. The Warden of Measures of old could, with his 25-inch rule, strike a quarter circle the circumference of which was a geometric cubit or metre.

The following authority for the existence of this geometric cubit is given. Professor Hommel ("Babylonia": Hastings's "Dictionary of the Bible") states: "It is further to be noted that in the latitude of Babylon (31° N. Lat.) the length of the second pendulum is 992·35 mm., which is almost exactly equal to the Babylonian double cubit (990 to 996 mm.)" derived from the scale of Gudea (*circa* 2500 B.C.).

Professor Kennedy ("W. M.," *ibid.*) gives the double cubit of Babylonia from the same source as about $39\frac{1}{4}$ inches.

Measurements I have taken from De Sarzec's plate of the Scale of Gudea give 39·256 inches. We may therefore assume that in the scale of Gudea the double cubit of Babylonia has been derived with π equal to $\frac{22}{7}$.

The probable variations in length of the geometric double cubit are here given:

	Inches.
Value with π equal to $(\frac{4}{3})^4$	39·506
Value with π equal to $(\frac{22}{7})$ (later)	39·285
Value with true π, and diameter 500,000,000 inches	39·269
Value of French metre	39·370

Thus the geometric standards of measure in use amongst the ancients were nearly identical with those of the present day—viz., inches and metres; but owing to our knowledge of the true value of π, and of the complicated shape of the earth, the subject cannot be treated with the same simplicity as it was formerly.

The (100) or Decimal System, Reducing all Weights and Contents by 2·4 Per Cent—Euboic System.

In this system the number of Geometric Rati is reduced from 4,096 in the Hon, to 4,000, and from 5,120 in the pint to 5,000, or 2·4 per cent. for the sake of convenience in calculations; practically a reduction of from 64 to 62·5 in the multiplier, so

that part of the (64) system merges into the decimal system. Thus $(10)^3$ was substituted for $(8)^3 \times 2$; at the same time the cube side of the vessel containing the Hon weight of water was fixed at 3 inches, giving 27 C.I. to the volume of the Hon and 33·75 C.I. to that of the pint.

Original Measures.		Revised Measures.					
Rati.	Name.	Rati.	Name.	Weight in C.I. of Water of Vessels when Filled.	Rati.	Name.	Weight in C.I. of Water of Vessels when Filled.
4,096	Original Hon	4,000	Hon	C.I. Hon 27	5,000	Pint	C.I. Pint 33·75
32,768	—	32,000		216	40,000	Gallon	270·0
262,144	—	256,000	Cubic foot of water	1,728	320,000	Bushel	2160·0
				13,824	2,560,000	Quarter	17280·0

This became the Euboic system, and was used early in Egypt and in Greece.

Under the (80 and 100) systems the Karsha, Kat (Egypt) or Suvarna (India) of 80 Rati (·54 C.I.) became a unit of measure, 50 Kat to a Hon.

By experiment it was found that a 3-inch cube of water weighed about 4,000 Rati, more or less, the pound weight, and thus the 3-inch cube of water became the fixed standard of weight equal to the pound (Hon) of 4,000 Geometrie Rati, but containing 3,200 Rati in bulk.

At the same time that the *weight* of 4,000 Rati was made equal to 3 inches cube of water, the *bulk* of 4,000 Rati was made equal to 33·75 C.I. (the pint), and this was an arbitrary arrangement, making Rati to water in weight as 64 : 80. Rati to act as standards in such a case would have to be picked out by the Wardens of Weights and Measures. But so far as one can judge, the weight and bulk of the Rati very nearly fulfil the requirement, and it is to be noted that at the present day the relation of barley to water is nearly as 64 : 80.

The 3 inches cube side of 27 C.I. thus became the standard of weight, measure, and capacity in early scientific calculation, and we have it at present with us as a proportional part of the foot and the yard.

Thus there was a standard measure, the pound, for liquids, and another ($1\frac{1}{4}$ in bulk) the standard for corn (the pint).

And whilst the greengrocer gives their relation in the following: "A pint is a pound all the year round," the vendor of liquids says with equal truth: "A pint of pure water weighs a pound and a quarter," the pint having now become common to both seeds and liquids.

It is doubtful whether the pint system, at first, was reckoned on as a standard, for the gallon weighed 10 pounds, the bushel weighed 80 pounds, and the quarter 640 pounds or 10 cubic feet. There was thus a very simple metric system in early times which we have lost owing to various causes. The 3-inch side cube—27 C.I. of water; both for weight and for capacity.

In addition there was a weight for precious stones and metals of $\frac{8}{10}$ the pound, equal to 3,200 Rati, in weight (21·6 C.I. of water) identical with the Tower pound and bearing the same relation (8 : 10) to the Hon that the Hon does to the pint.

There was the following decimal system for metal weights:

Rati.		
32	...	Quarter shekel.
320	...	Pala (India).
3,200	...	(Tower pound) Dharana of gold.
32,000	...	8 Hon.
320,000	...	Bushel.

The following standard weights came into use:

	Rati.	Rati.	
80 Tower pounds	(3,200)	= 256,000	The cube of 12 inches 1,728 C.I.
64 Hon ...	(4,000)		
100 Tower pounds	(3,200)	= 320,000	The bushel, 2,160 C.I.
80 Hon ...	(4,000)		

It to be noted that this 1,728 C.I. was an original independent measure, and only became a cubic *foot* in later years when the yard cube was originated. Other cubic feet were $\frac{1}{27}$ of their respective double cubits cubed, but the original British cubic foot was absorbed only in later years as $\frac{1}{27}$ of the cubic yard.

The revision of 4,096 Rati to 4,000 Rati took place after the nations had commenced migrating east and west, from their undivided habitats, so that we in the British Isles inherit the pound system on the original scale (64) and the Tower pound and

TABLE I.

SHOWING DEVELOPMENT OF EARLY WEIGHTS AND MEASURES FROM THE ORIGINAL GANDA SYSTEM (MULTIPLE BY FOURS).

The Weights have still remained on the (64) System; but the Measures of Capacity have been, in many countries, increased 25 per cent. The two systems giving us both the Cubic Foot and the Bushel, 4 : 5.

The Rati are weights: 32 Rati = 54·54 Grains Troy = 54 O.G.T. ∴ (at 250 O.G.T. to the C.I.)

$$27 \text{ C.I.} = \frac{27 \times 250 \times 32}{54} = 4{,}000 \text{ Rati.}$$

The Original Ganda System.		(64) System.	(64) reduced by 2·4 Per Cent.			Measures of Capacity.							
Name.	Weight in Rati.	Rati.	Rati.	Name.	Capacity, C.I.	(80) System. Rati.	(80) reduced by 2·4 Per Cent. Rati.	Aryan Names (from Colebrooke's Essay).	Egyptian Names.	British Names.	Capacities (80) reduced by 2·4 Per Cent. C.I.	Capacities (80). C.I.	Imperial Measure. C.I.
$\frac{1}{10}$ shekel	8	8	—	—	—	10	—	—	—	—	—	—	The modern Imperial measures closely follow the old system.
Dueat	32	32	—	—	—	40	—	—	—	—	—	—	
—	—	64	—	—	—	80	—	Karsha	Kat	—	—	—	
Shekel	128	128	—	—	—	160	—	—	—	—	—	—	
—	—	256	—	—	—	320	—	Pala, Belwa	—	—	—	—	
4 shekels	512	512	—	—	—	640	625	Cunchis, Cudava,	—	—	—	—	
—	—	1,024	—	—	—	1,280	1,250	Sattiea	—	Gill,	—	—	
16 shekels	2,048	2,048	—	(Seer)	—	2,560	2,500	—	—	—	—	—	
—	—	4,096	4,000	1 Hon	27	5,120	5,000	Puschala	—	Pint	33·75	34·55	34·659
—	—	8,192	—	—	—	10,240	10,000	—	—	Quart	—	—	—
—	—	16,384	—	—	—	20,480	20,000	Adhaea	—	Pottle	—	—	—
—	—	32,768	32,000	8 Hon	216	40,960	40,000	—	Hekt	Gallon	270·0	276·4	277·274
—	—	65,536	—	—	—	—	80,000	Drona	—	Peek	—	—	—
—	—	131,072	—	—	—	—	160,000	$\frac{1}{10}$ Combha	Apit	Tovit	—	—	—
	—	262,144	256,000	64 Hon	1,728	327,680	320,000	Maniea	—	Bushel	2160·0	—	2218·191
						655,360	640,000	—	Ram	Strike	—	—	—
						1,310,720	1,280,000	Cheri, eubit eubed	—	Combe	8640·0	—	—
						2,621,440	2,560,000	10 eubie feet.		Quarter	17280·0	17695·0	17745·526
						5,242,880	5,120,000	—		—	—	—	—
						10,485,760	10,240,000	Double eubit eubed, 40 cubic feet.		The 4 quarters	—	—	—

cubic foot system on the revised scale (80 and 100), resulting in a discrepancy of 2·4 per cent. We have also lost 1 per cent. on our grain Troy during the Middle Ages, and thus we have got a very dilapidated remnant of the simple metrical scale of the ancients, which could be made so useful to us if re-established and revised.

The Double Building Cubit ($41\frac{2}{9}$ inches).

The geometric cubit was used for geographical measurements and linear measure, but for building purposes and circular and cylindrical measure the only available method was to employ the system adopted in the quadrature of the circle, and use the double cubit of $41\frac{2}{9}$ inches, giving a volume cube of 70,000 cubic inches, or a cylinder of 28 inches height and radius. (See p. 10.)

This new measure is recorded on the Great Pyramid, and is the nucleus of a new system, being independent of the systems (64), (50), and (100); but it is intimately connected with them, the volume of the double cubit cubed lying almost exactly midway between the volumes of the 4 quarters of the (80) system and the 4 quarters of the (100) system, as shown below:

Early measures { 4 quarters (80) system, 70,778 C.I.
4 quarters (100) system, Euboic, 69,120 C.I.

Pyramid or Eginetan measure, 28-inch cylinder or $41\frac{2}{9}$ cubed { 70,000
70,048 C.I.
69,984 C.I.

Note that the Euboic (69,120) is to the Eginetan (69,984) in the proportion 80 : 81.

The terms "Euboic" and "Eginetan" are used because these measures subsequently were known by these names to the Greeks.

Though the double building cubit and the geometric double cubit are not directly connected, they bear a relation to each other nearly as 20 : 21 : 39·259 or $39\frac{7}{27}$: $41\frac{2}{9}$. The length now adopted by Professor Petrie for the double cubit is 41·203 inches, and is accepted generally (see "Encyclopædia Britannica," Weights and Measures, note 1). The standard of $41\frac{2}{9}$ inches I have taken from the base of the Great Pyramid as measured by Petrie, and it can be relied on as the most accurate record of the building double cubit.

The Double Building Cubit Cubed.

Hitherto the limit of measures of capacity was the bushel, or possibly later the 8 bushels, or quarter; but with the introduction of the double cubit cubed the limit became 32 bushels. Thirty-two bushels, however, are short of the double cubit cubed as 80 : 81, so that they measure 40 cubit feet, whilst the double cubit cubed measures 40·5 cubic feet.

These, then, were two representatives of the double cubit cubed, that of 40 cubic feet (or 6,912 C.I.) being subdivided binarily (Euboic), and that of 40·5 being subdivided on the sextarial system.

The progression was now by division by 8 *from* the double cubit cubed of 69,120 C.I. downwards instead of from a unit number of Rati upwards, as follows:

TABLE II.

Revised Euboic, from Pyramid.

Name.	Side Cube.	Side Cylinder.	Weight Hon.	Content C.I.
	Inches.	Inches.		
Kat	—	—	—	0·540
Hon	—	—	1	27·000
Gill	2·576	1·75	$\frac{5}{8}$	16·875
Pottle	5·152	3·50	5	135·000
Tovit / Apit Dell ...	10·305	7·00	40·0	1080·000
Combe / Cubit cubed	20·611	14·00	320·0	8640·000
Double / Cubit cubed	41·222	28·00	2560·0	69120·000

The side cube of 70,048 C.I. is here given (41·22 inches) because it is thought that this standard would be adhered to by the ancients, but the actual side cube of 69,120 is 41·04 inches.

By a happy coincidence the height of the 8 bushel cylinder (the cubit of a man) is almost identical with $\frac{3}{7}$ of the side of the double cubit cubed of 32 bushels, and thus not only does the old cubit of a man cylinder form an integral portion of the double cubit cubed cylinder, but the cubit of a man is to the building cubit as 6 : 7 (always recollecting the proportion of the old Euboic volume to the new Eginetan volume being as 80 : 81).

In the countries about Babylonia and Egypt the new Eginetan system appears to have come into use, with its sextarial divisions, but in India and Western Europe the Euboic continued in use, and the limit of capacity was from one to eight bushels.

The question will now arise, How are the inches in the 32-bushel cylinder side to synchronize with the $41\frac{2}{9}$ inches of the side cube, seeing that the value given to π in the formation of the cylinder is far above its true value : $(\frac{5}{3}\frac{3}{6})^3 = 3{\cdot}19 : \pi = 3{\cdot}14159$? The reply is that the content used in the cylinder is the Euboic measure, which is short of the 70,000 as 80 : 81, owing to the multiplications by 8, and the two discrepancies neutralize each other to so great an extent that the Euboic measures only differ from those arrived at by calculations, with the true π, by 158 C.I. in 70,000.

The following are the various values :

	C.I.	Cubic Feet.	Cubit of a Man.
The original (80) or Octogintal quarter (8 bushels). (5,120) 8^3 Rati $\times 4$	70778·88	40·96	17·72
The Euboic quarter (8 bushels). (5,000) 8^3 Rati $\times 4$	69120·0	40·0	17·58
$41\frac{2}{9}$ inches cubed	70048·0	40·5	17·66
28-inch cylinder equal height and radius. $\pi = (\frac{2}{1}\frac{5}{4})^2$	70000·0	40·5	17·66
28-inch cylinder equal height and radius. True π	68992·0	39·9	17·57
Double cubit cubed. Eginetan 2,160 logs of 32·4 C.I.	69984·0	40·5	17·66

It will be seen that the extreme variation of the fathom in any cases can only be 0·56 inch.

Commencement of the Sextarial System.

The next point to settle is how the double building cubit is to be divided into digits, and the relation which the three cubits are to have to one another—viz., the double cubit of $41\frac{2}{9}$, the cubit of a man of 17·66 inches, and the Gudean cubit of 39·259.

The proportion is as follows :

$$21 : 9 : 20 :: 41\tfrac{2}{9} : 17\tfrac{2}{3} : 39\tfrac{7}{27}.$$

The digit is already fixed to a certain extent by the proportion 9 : 21, if the cubit of a man and the double building cubit are to form parts of one cubit. The cubit of a man is $\frac{6}{7}$ of the new building cubit, and must be divided by six, thus giving 24 digits to the cubit and 96 to the fathom. The building cubit has therefore 28 digits.

	Fathom.	Digit.
Original cubit of 17·66 inches	64 divisions	1·103 inch
,, ,, ,, ,, ...	80 ,,	0·883 ,,
,, ,, ,, ,, ...	100 ,,	0·706 ,,
,, ,, ,, ,, ...	96 ,,	0·736 ,,
Pyramid or building cubit, 20·61 inches...	112 ,,	
Original geometric cubit, 39·506 inches. $(\frac{4}{3})^4$	100 ,,	0·79012 ,,
Scxagesimal geometric cubit, 39·285 inches. $(\frac{2}{7}^2)$.	100 ,,	0·7857 ,,
	120 ,,	0·6547 ,,
Greek foot, 25 digits } Table IV.	100 ,,	0·7275 ,,
Roman ,, 24 ,, }	96 ,,	

The full volume of the sextarial double cubit cubed (69,984 C.I.) does not appear to have been divided up binarily, and there is no evidence at present of the order of sequence of its sextarial divisions, but the following is suggested :—

(1) By 12 we have the Khar of 5,832 C.I., and by $(12)^3$ we have the ancient pint, 40·5 C.I., p. 31.

(2) By 30 we have the Bath or Artaba of 2332·8 C.I., pp. 38, 40 and 59.

(3) By $(3)^3$ we have the Babylonian cubic foot of comparatively late times ·2592 C.I., p. 41. The cubic foot divided by $(8)^2$ gives the ancient pint 40·5 C.I., p. 31.

Cylindrical Measures of Later Times.

There was another development in cylindrical measures. By raising the Euboic measures of capacity as 15 : 16, the 17·66-inch cylinder became an 18-inch cylinder (Table III.) ; so that the side of cube and side of cylinder are as 53 : 36 (see Quadrature of the Circle) ; thus the dimensions of both cube and cylinder are

TABLE III.

Comparison of Ancient Cylindrical Measures.

A	Euboic Measures (80) and (100). $\pi = \frac{22}{7}$.					B	18 Inch Cylinder. $\pi = (\frac{4}{3})^4$.				
	Side Cube.	Side Cylinder.	Kat.	Hon.	Content C.I.	Side Cubo.	Side Cylinder.	Grains Troy.	New Hon.	Content C.I.	
	Inches.	Inches.				Inches.	Inches.				
Kat	—	—	1·0		0·54	—	—	—	—	—	—
Hon	—	—	50·0	1	27·0	—	—	7,200	1	28·8	—
Pint	3·24	2·207	62·50	$1\frac{1}{4}$	33·75	3·312	2·2	9,000	$1\frac{1}{4}$	36·0	—
Gallon	6·48	4·415	500·0	10	270·0	6·625	4·5	—	10	288·0	—
Bushel... ...	12·96	8·83	4000·0	80	2160·0	13·25	9·0	—	80	2304·0	Artaba.
Quarter ...	25·92	17·66	32000·0	640	17280·0	26·5	18·0	—	640	18432·0	—
—	41·22	28	—	2,560	69120·0	53·0	36·0	—	5,120	—	—

Note.—Both these sets of measures are on the Euboic scale ; if the capacities are increased, as 80 : 81, to bring them up to the Eginetan Scale the content of the 18-inch Hon will be 29·16 C.I., as given by Mr. F. L. Griffiths (see p. 31).

Tables A and B nearly coincide with Imperial Liquid Measure and Old English Ale and Beer Measure.

This Artaba of 2,304 C.I. weighs 100 Troy pounds : see p. 41.

expressed in inches. Table III. also shows that the revised hon of 27 C.I. ($\frac{1}{64}$ cubic foot) was at some remote period raised to 28·8 C.I. ($\frac{1}{600}$ cubic foot): probably at the beginning of the sexagesimal period.

Possibly it was the same northern race that introduced the Khar, or 18 inches cube, into Egypt during Fourth to Seventeenth Dynasties. See "Notes on W. and M.," by F. L. Griffiths (Proceedings of Soc. Biblical Archæology, 1891-2). The contents of 12 Khar, or $1\frac{1}{2}$ cubic yards, exactly equal the double cubit cubed of 69984 C.I.

Geometric Linear Measure.

Sir John Herschel pointed out in 1869 that if the polar axis of the earth be divided into 500,000,000 units or geometric inches, the geometric inch will be to the imperial inch as 999 to 1,000. Mr. Piazzi Smythe has put this in another way. The earth's axis of rotation measures 500,500,000 imperial inches.

The suggestion being that this number of units was not a coincidence, but was the result of astronomical measurements made in very early days when the geometric inch was fixed on as a standard, $\frac{1}{500000000}$ of the earth's axis.

Professor F. Petrie ("Inductive Metrology," p. 111) gives the average inch in buildings in England as 0·9998 inch, and says: "The inch, as now in use, has not varied any appreciable amount, on the average, for centuries."

In the ancient calculations in connection with the cubic contents of cylinders and of foot cubes it will be found that the inch comes in as a factor in length, and there cannot be a doubt but that it was used in all the calculations, though not in general use amongst the people, except in the cases of those people who used the cubic foot, the 18-inch cylinder, and the Khar (18-inch cube). As already shown, the side of a cube equal to the number 70,000 is $41\frac{2}{9}$, and 220 of these equal 9068·8̇. Petrie measured the base side of the Great Pyramid to be 9068·8 inches, and gave the average contents of each stone in the Pyramid as $(50)^2$ inches by 28 inches, equal to 70,000. The 39·28-inch double cubit of Gudea is supposed to be derived from the

earth's diameter of 500,000,000 inches. Everything indicates that the imperial inch is identical with the geometric inch used in early days. The astronomical measurements above mentioned must have taken place before the building of the Great Pyramid and before the time of Gudea of Telloh.

The earliest classical records we possess concerning measurements of the earth's surface are in the writings of Aristotle, to whom the astronomical records of Babylonia were sent 330 B.C. He states that the most ancient measures of the earth's circumference were adopted by Thales, and Anaximander, about 600 B.C.; that it was divided into 400,000 Stades. In the time of Aristotle the Sexagesimal system had been in use for centuries in Babylonia, and the number of Stades in a circumference of the earth was $360 \times 60 \times 10 = 216{,}000$ Stades of 10,000 digits; the inference, therefore, is that this 400,000 Stades was an ancient measure anterior to the Sexagesimal system. This, at 500,000,000 inches to the earth's diameter, makes the Stade 329·21 feet (3950·6 inches), or 100 double cubits of 39·506 inches.

Aristotle also refers to 1,111 Stades to a degree. This number marks the change from the (80) and (100) systems to the (60) system: $400 \times 1{,}000 = 400{,}000$ Stades; $360 \times 1{,}111 = 399{,}999$, or 400,000 Stades.

It may be assumed, then, that the earliest geometric cubit known to us is that recorded in the Statue of Gudea, 39·28 inches, its original form being 39·506 inches; digit, 0·79012 inches.

When the Sexagesimal system came in, the cubits of 39·5 and 39·28 inches became unsuitable for geometrical purposes, and another division and cubit was introduced: 360 degrees to circumference, 60 minutes to a degree, and 100,000 digits to a minute, giving a digit of 0·7275 inch, and the Olympic foot and cubit of 12·124 and 18·187 inches. Subsequently another change was made into the Roman foot, but still retaining the same digit.

In India at the present day the geometric double cubit of early days is still in use. 10,000 Cos of 2,000 fathoms (4,000 double cubits) equal the earth's circumference; or 25,000 miles of 800 fathoms (16 double cubits) equal the earth's circumference.

The Cos is, therefore, 4,387 yards, and the mile 1,755 yards (see Table IV.).

TABLE IV.

Ancient Linear Measures, showing various Systems of Geometric Cubits derived from Measuring the Arc of a Meridian in Early Days.

The Ancients estimated the diameter of the earth to be 500,000,000 inches, which is correct to about 1 in 1,000. The Imperial Inch is thus practically identical with the original inch. In the binary calculations $(\frac{4}{3})^4$ was used for π, and in the Sexagesimal calculations $(\frac{22}{7})$ was used. The Ancients, in binary calculations, used the cubit 39·5 and digit 0·79012 inches, and in Sexagesimal calculations the digit 0·7275 inches was used both in the Babylonian, Greek, and Roman systems.

Circumference of earth $\left.\begin{matrix}(\frac{4}{3})^4 \\ (\frac{22}{7}) \\ \pi\end{matrix}\right\} \times 500{,}000{,}000$ inches = $\left\{\begin{matrix}1{,}580{,}246{,}913 \text{ inches, } 39{\cdot}506 \text{ double cubit.} \\ 1{,}571{,}428{,}571 \text{ ,, } 39{\cdot}285 \text{ ,, ,,} \\ 1{,}570{,}796{,}326 \text{ ,, } 39{\cdot}269 \text{ ,, ,,}\end{matrix}\right.$

,, ,, Metrical System 1,574,804,520 ,, 39·370 French mètre.

	Cos, League.		Mile.		Furlong.		Fathom.		Double Cubit.		Cubit.		Foot.	Digit.
	Digits.	Yards.	Digits.	Yards.	Digits.	Inches.	Digits.	Inches.	Digits.	Inches.	Digits.	Inches.	Inches.	Inches.
$(\frac{4}{3})^4$ Europe 25,000 miles of 102,400 digits	—	—	102,400	1,755	12,800	7901·2	128	79·01	64	39·5	32	19·75	—	0·617
,, India and Europe 10,000 Cos (leagues) of 200,000 digits	200,000	4,387	80,000	1,755	10,000	7901·2	100	79·01	50	39·5	25	19·75	—	0·79012
,, Persia and Babylonia — 6,250 Parasang of 320,000 digits	320,000	7,023	—	—	11,520	94620	96	75·85	—	—	32	25·233	—	0·79012
,, Europe 25,000 miles of 80,000 digits ...	—	—	80,000	1,755	10,000	7901·2	100	79·01	50	39·5	25	19·75	—	0·79012
,, Britain ... — 24,900 miles of 1,760 yards: two systems combined	—	—	80,000	1,760	10,000	7920·0	100	79·2	50	39·6	25	19·8	—	0·792
					11,000	7920·0	100	72·0	50	36·0	25	18·0	—	0·720
,, Moslem, Persian — The mile of Almamun: Babylonia	—	—	90,000	1,975	—	—	—	—	Old cubit		25	19·75	—	0·79012
									Black cubit		27	21·33	—	—
,, Moslem, Persian — Assyria	288,000	6,320	96,000	2,106	—	—	—	—	Greek foot		24	18·96	—	—
									Hackem foot		32	25·28	—	—
$(\frac{22}{7})$ Roman .. — 360 degrees of 75 miles 27,000 miles of 5,000 feet (or 80,000 digits)	—	—	80,000 (5,000 Roman foot)	1,616	—	—	—	—	—	—	24	17·46	11·64	0·7275
						Stade Inches.								
$(\frac{22}{7})$ Babylonian and Greek — 360 degrees of 60 minutes of 100,000 digits	—	—	100,000	2,020	10,000	7,275	100	72·75	50	36·36	25	18·187	12·124	0·7275
$(\frac{22}{7})$ Alexandria, A.D. 100. 25,000 miles	—	—	72,000	1,746	9,600	8,380	96	83·8	—	—	24	20·95	—	0·873
Nautical miles... ... 360 degrees of 60 minutes or nautical miles	—	—	—	2,026	—	7,296	—	—	50	36·48	Nautical		—	0·7296
Proposed English mile	—	—	72,000	2,000	9,000	9,000	72	72·0	36	36·0	—		—	1·0

The following instances of modern lengths of Cos are given:

	Yards.
"Cyclopædia of India." 2,000 danda of 4 double Hasta of 19·5 inches	4,333·3
Petrie { "Burmah." 1,000 Dhas at 8 × 19·25 inches	4,277·0
Petrie { "Siam." 8,000 Sok of 18·96 inches ...	4,213·0
Colebrooke's "Essays, Asiatic Researches," vol. v. ...	4,000·0
Prinsep's "Useful Tables," with black cubit, 4,558 yards	
Deduct $\frac{1}{30}$ 152 „	
4,406 ...	4,406

25,000 miles to the circumference of the earth at 80,000 digits to the mile gives a digit of 0·79012 inch. It is to be found in Europe and Asia, and is probably the foundation of the Moslem digit of 0·79 inch, and the British digit, 0·792 inches ($\frac{1}{10}$ link).

Note (1)—Loss of 1 Per Cent. in Weight of Troy Grain in Middle Ages.

I give a number of instances, showing that by accepting the Troy grain as defective in weight by 1 per cent., the comparison of ancient weights and standards closely agrees with existing weights.

	Weight, G.T.	Reduced by 1 per cent. G.T.	Correct Weight, O.G.T.
Kelly's "Cambist," 1824. Existing Roman pound	5,234	—	—
Kelly's "Cambist," 1824. Florence and Leghorn	5,240	—	—
Mean	5,237	5,185	5,184
Hussey's estimate of Roman Empire pound	5,204	—	—
Clark's estimate of Roman Empire pound	5,240	—	—
Arbuthnot's estimate of Roman Empire pound	5,249	—	—
Congius of Vespasian	5,204	—	—
Mean of 4	5,224·2	5172	5,184
Queipo, 100 Attic drachmas	6,557·7	6,492	6,480
„ „ Ptolemy drachmas	5,460	5,406	5,400
„ „ Euboic drachmas	9,090	9,000	9,000
Hussey's shekel	218	216	216
Cubic inch of water, 1798 { distilled ...	252·45	249·9	250
Cubic inch of water, 1798 { well ...	252·65	250·1	250

CHAPTER II

THE SEXTARIAL AND SEXAGESIMAL SYSTEMS

Radical Change of System in Babylonia and Egypt about the Time of the First Egyptian Dynasty.

The change in measures from Binary to Sextarial (and Sexagesimal), or, in a word, from the use of (80) and (100) to (6) and (60) systems, in weights and measures, was so radical a break with the past that it could not possibly have taken place in the common life of the people, all the world over, without some all-compelling influence, of which our records give no indication.

It is necessary, then, to ascertain how far this change extended over the nations of the world, and what were the limitations of the change in the weights and measures themselves.

Geographical Limits of the Change.

It may be said, in brief, that this change did not extend beyond the civilized lands of those days — *i.e.*, it did not extend beyond the corn lands of the Euphrates and Nile Valleys, and Armenia, Persia, and Asia Minor, until about 1000 B.C. About 300 B.C., Roman influence extended the Sextarial system in a modified form throughout the empire.

East of Persia and Arabia, in Russia, China, India, Japan, Malaya, and in all Northern Europe, the systems appear to have remained for the most part Binary and Decimal (64), (80), and (100), and Egypt, when under its native rulers, was also inclined to the same.

The change took place (in early days) in the cornlands of the civilized world alone; partly, no doubt, because people now found that barley and wheat were more handy and convenient to use than the seeds of the wild Rati. But this in itself would

not cause the change, though it may have removed the opposition of the people. The actual cause, no doubt, was the advance of education. Mankind were now no longer limited, in calculations, to halving and doubling; they could now add two to four, and make six of it; and the wise men at the head of affairs were bound down and fettered by the new system they had themselves introduced, to the use of 81 instead of 80 in their calculations.

The change was not only limited to the regions indicated, but the application of the new system was also necessarily very much limited, the multiples 2 and 5 being necessarily also freely used. The limit of weight and measure, on the one hand, was the double cubit cubed of 70,000 C.I. (taken as 69,984 C.I.); on the other hand, the Rati was fixed absolutely at 4,000 Rati by weight to 27 C.I. of water. The number of multiples of 3 was, therefore, dependent on the number of cubic inches, which the wise men took to represent the volume of 70,000 C.I. In the Euboic system, with the Binary calculations they could not get nearer than 69,120 C.I., but in the Sextarial system they got as near as 69,984 C.I.

This latter amount contains five multiples of 3, and consequently this was the limit. The number 69,984 is made up of $(6)^5 \times 9$. The two systems are compared:

Euboic: 27 C.I. $\times$ 80 $\times$ 32 = 69,120 C.I. = 32 bushels weight of water = 40 British cubic feet.

Eginetan: 27 C.I. $\times$ 81 $\times$ 32 = 69,984 C.I. = 27 Babylonian cubic feet = 40·5 British cubic feet.

Thus, these two systems are to each other as 80 : 81 for bulk and weight.

The Eginetan and Gudean Systems.

The change, however, was not merely one of bulk and weight ($2^4 \times 5$ to 3^4) 80 to 81. The standard of small weight was also changed in two directions under the two systems—Eginetan (Sextarial) and Gudean (Sexagesimal). Each of these systems will be described individually, but it is necessary to compare them together and note to what extent they are similar, and how far they differ. They both had a small standard of barley

weight, but whilst the Eginetan system was made use of as a popular measure, the Gudean system seemed to be more scientific and artificial and was exclusively used in one part of Babylonia until the Phœnicians introduced it in a modified form to the world in later times.

The two systems (different in many essential respects) appear to have been elaborated under one central management, and were worked together. The Eginetan is a combination of sixes, the Gudean a combination of sixties. The Eginetan system is recorded in the coffer of the Great Pyramid in Egypt, where the Euboic system held sway, and in Western Babylonia; whilst the Gudean system in early days was confined to Eastern Babylonia We must, then, look to Babylonia as the centre from which these new systems of multiplication by 3 emanated, though it was ratified and confirmed in Binary and Decimal Egypt at the building of the Great Pyramid.

We must look upon Babylonia as divided into two parts, which for the sake of convenience we will call East and West Babylonia, though it seems more probable that then, as now, the scientific wise men used the Gudean system, whilst the people held on to the more natural Euboic and Eginetan systems. Thus, whilst the agricultural people of Western Babylonia took into use a weight of 3 barley-corns (equal by weight to 2 Rati), those in Eastern Babylonia adopted a cubic inch of water as their standard, to which they made 250 grains (Troy barley grains) equal in weight, so that 27 Troy barley grains were equal in weight to 16 Rati—an absolutely artificial system:

Thus the revised Hon of 27 C.I. = { 4,000 Rati, or / 6,000 ancient barley-corns. / 6,750 grains Troy, or Gudean,

giving the proportion of 16 : 24 : 27.

These two barley-corns (Eginetan and Troy) had each, their wheat companions, so that, taking the Ducat or Varaha (54 O.G.T.) as the standard, their proportions were as follows:

32 Rati = { 48 Eginetan barley-corns = 64 Eginetan wheat. / 54 Troy or Gudean corns = 72 Troy wheat.

The Euboic measure also subsequently took the Eginetan barley-corn into use in lieu of the Rati.

The Gudean System.

The Gudean system had its origin in the double cubit derived from the measurement of an arc of the meridian, $\frac{1}{40000000}$ of the circumference of the earth, corresponding to the modern French metre. It seems to have been slightly modified in later times so as to fit in exactly with the Eginetan system. As will be seen from the following figures, but little alteration was required :

	Inches.
French metre of modern metrical system	39·370
Gudean geometric double cubit $(\frac{4}{3})^4 = \pi$	39·506
„ „ „ „ $(\frac{22}{7}) = \pi$	39·285
$\frac{20}{21}$ of Pyramid double building cubit of $41\frac{2}{9}$ inch ...	39·259
Gudean double cubit from statue of Gudea (Kennedy)	39·250
„ „ „ De Sarzec's plan (Warren)...	39·276
Cube root of $\frac{6}{7}$ double building cubit cubed, 60,000 C.I.	39·148

	Content of Cube.	Double Mina.	
Name.	C.I.	G.T.	O.G.T.
One Cubic Metre ...	61023·9	15,432	15,288
Babylonian Mina ...	—	15,160	15,010
$\frac{6}{7}$ Double cubit cubed	60000·0	15,150	15,000

From these figures it will be seen that starting with the geometric double cubit of 39·285 inches, the Babylonians were able, with no appreciable error, to accept 60,000 C.I. as their standard of heavy weight.

M. Hommel ("Babylonia," Hastings' "Dictionary of the Bible") states that the cube on the double cubit of the Statue of Gudea was divided into 1,000 parts, or minas, each weighing nearly a litre, or about 60 cubic inches of water. The mina was divided into 60 shekels, so that each shekel weighed a cubic inch of water. The following is a description of the shekel :

The Gudean Shekel.

On the sitting Statue of Gudea found at Telloh (Larsa), in Southern Babylonia, probably contemporaneous with the Fourth Egyptian Dynasty, there is a cubit scale cut on the hard stone with great care. There are 16 divisions shown, 63 of which equal the length of the double cubit of the Great Pyramid, and 60 of which form the double cubit of Gudea.

This double cubit cubed equalled 60,000 cubic inches, and contained 1,000 double minas of 60 cubic inches each. The weight of a cubic inch of water being a shekel weight, and the double mina weighing 15,000 O.G.T.

The weight of the double mina is given by Professor Kennedy ("Weights and Measures," Hastings' "Dictionary of the Bible") from actual testing, as 15,160 G.T., which deducting 1 per cent. gives 15,010 O.G.T.

The weights found are said to have existed at least 2,000 years B.C. Thus we have good reason to suppose that the cubic inch of water shekel goes back at least to the time of Gudea, in Southern Babylonia. And as Elam and Persia came under the influence of the Accad monarchs, we may assume that this Gudean system may have come into use in Persia at an early date.

Again, we know from the coins of the Persian kings, dating as far back as 518 B.C., that the gold darics weighed two to a cubic inch of water, and that the silver siglos weighed three to a cubic inch of water or Gudean shekel, and the daric of the Lydian kings, dating as far back as 560 B.C., have the same weight.

It is evident that the Gudean shekel had not altered up to the end of the Persian supremacy.

Again, in later times we have the Olympic standard in Greece, of which the pound was the single mina of 7,500 O.G.T. or 30 cubic inches of water.

We have testimony also that the Persian daric had an extensive circulation in Greece (Xen., "Anab.", i. 3). These coins are supposed also to have been struck in Egypt during the reign of Cambyses of Persia; and there is evidence that the

shekel weight of a cubic inch of water was in use amongst the Phœnicians after the Persian supremacy was overthrown.

We have then good reason for supposing that the Gudean single mina of 7,500 O.G.T. and the shekel of 250 O.G.T. were extensively used in the Levant up to the time of the Ptolemies and Seleucidæ.

We have, moreover, the Roman pound during the Consuls weighing about 5,000 O.G.T., probably $\frac{2}{3}$ of the Gudean pound, and we have the same pound in use in the Greek States in Asia Minor, during the Early Roman period.

The Gudean Pint and Mina.

Professor Hommel states that the Babylonian talent consists of 60 minas (3,600 C.I.) and the light talent of 30 minas (1,800 C.I.); but this was in comparatively later times. No doubt the talent of later times was 1,800 C.I., the Olympic or Phœnician trade talent; but we have no evidence as to the original Gudean talent.

There are some peculiarities about the Gudean measures. Liquid measure appears to have been in proportion to dry measure as 3 : 4, instead of 4 : 5, a proportion probably forced on by the Sexagesimal system, giving a standard of 40 C.I. for the pint. Other nations using 60 pounds to the talent probably followed suit.

In process of time this discrepancy in relation to the Binary and Eginetan measures must have been felt, and about 800 to 1200 B.C. a change appears to have been made, and the mina was raised from 30 C.I. to 32 C.I.

The whole subject will be found more fully treated of in the Quadrilateral Tables. The following shows briefly in cubic inches the alterations made, in Gudean measure, which I have arrived at inductively:

	Talent.	$\frac{1}{60}$	$\frac{1}{64}$	$\frac{1}{80}$	$\frac{1}{100}$
Eginetan ...	2,592	Mina, 43·2	Pint, 40·5	Log, 32·4	Pound, 25·92
Gudean { Early	2,400?	,, 40·0	—	,, 30·0	,, 24·0
Gudean { Later	2,560	,, —	,, 40·0	,, 32·0	,, 25·6

The Eginetan or Sextarial System.

When the double cubit cubed of 70,000 C.I. was established as the standard of weight and measure, the method of dividing it sextarially had to be settled, and fortunately the number 69,984 C.I. was very suitable, being only out by about 1 in 4,000. The side cube could be divided by 2, 3, 6, and 12. By 2 the cubic cubit was formed; by 3 the cubic foot was formed; by 6 we have $\frac{1}{8}$ cubic foot or 324 cubic inches (10 log); by 12 we have a measure of 40·5 C.I. It seems probable that this latter was the first division—viz., into $(12)^3 = 1728$ parts, each $\frac{1}{64}$ of the Babylonian cubic foot, and 3·435 inches a side.

Now we know that in the Euboic system the $\frac{1}{64}$ part of the bushel is the pint, and reasoning by analogy we may surmise that 40·5 C.I. was the original Eginetan pint, to which $\frac{4}{5}$ (40·5) = 32·4 C.I. would be the Eginetan pound (the log). We may now put the two systems together in order, all C.I.:

Name.		$\frac{1}{64}$	$\frac{1}{60}$	$\frac{1}{80}$	$\frac{1}{100}$
Euboic bushel	2,160	Pint, 33·75		Hon 27 C.I.	21·60
Eginetan cubic foot	2,592	,, 40·5	Mina 43·2 C.I.	Log 32·4 C.I.	25·92

Thus we have a complete analogy between the two systems, arising from the divisions of the double cubit cubed by 27×64. The mina of 43·2 C.I. is the well-known Eginetan mina of 10,800 O.G.T. ("Dictionary of Greek and Roman Antiquities" gives 11,000 G.T.). Also 32·4 C.I. is the Babylonian log, and 25·92 is the Attic pound.

It seems, then, probable that the original division of the double cubit cubed for *capacities* was by the Pyramid pint of 40·5 C.I.; the log of 32·4 C.I. being the pound, and that subsequently the log of 32·4 C.I. became the measure of capacity (the pint) and that $\frac{4}{5}$ (32·4) = 25·92 C.I. became the pound.

In support of this we have the record (see Griffiths' "Notes") that in the Sixteenth Dynasty and earlier the Khar was in use, equal to 144 volumes of 40·5 C.I. and $\frac{1}{12}$ of double cubit cubed. I give below what appears to have been the original measure and the change:

Pints of 40·5 C.I. 64 to Bab. cubic foot.		Early. C.I. [5	Later. C.I. 4]
Original pint	1	40·5	Log, 32·4
	6	243·0	194·4
	36	1458·0	1166·4
	72	2916·0	Artaba, 2332·8
The Khar	144	5832·0	4665·6
	288	11664·0	9331·2
Double cubit cubed ...	1,728	69984·0	—

In the Tablet of Senkereh (eleventh century B.C.) the units of length are in the proportion 1, 6, 12, 72, 2160, and the measures of capacity run in the proportion, 6, 18, 36, 180.

The Khar.

Mr. F. L. Griffiths, F.S.A., in "Notes on Egyptian Weights and Measures" (Proceedings of Society Bib. Archæology, 1892), gives the following information concerning the Khar, which he derives from various Egyptian records.

He takes the Khar at $\frac{2}{3}$ (cubit)^3 equal to $\frac{1}{12}$ (double cubit cubed), the cubit being taken at 20·6 inches; he therefore makes the Khar 5827·88 C.I. (the standard I have deduced being 5,832 C.I.).

He states that the Khar was superseded at, or before, the Eighteenth Dynasty, by the sack of 16 Hekt (291·6 C.I.) or Ptolemaic Medimnus (4665·6 C.I.), the double Artaba. Apparently the Khar came into Egypt with the Hyksos. The Hekt is 10 *henu* or Hon. The *henu* was thus 29·16 C.I. At this time, then, in Egypt the Hon of 27 C.I. had been raised as 15 : 16 and again as 80 : 81.

The Khar was, therefore, 200 of the later *henu* (29·16 C.I.) or 216 Hon of 27 C.I. = 5,832 C.I.

We have no record as to the period when the Hon was raised from 27 C.I. to 29·16 C.I., but there is this significant fact. Eighty Hon of 29·16 = 2332·8 C.I., the Artaba of Greece (the Bath of the Babylonians), or $\frac{1}{30}$ of double cubit cubed. So that it would appear that the raising of the Hon from 27 C.I. to 29·16 was a method adopted by the Egyptians of keeping to the Binary system whilst using the principal measure of the Sextarial system. There seems to have been a constant tendency to

revert to Binary measure, the people in their daily life requiring quite a different measure to the wise men who calculated in their chambers.

Evidence concerning the Eginetan System.

Authorities appear to agree that the Eginetan talent was from 93 to 95 pounds avoirdupois, the sources of evidence being principally the monuments, history, coins, and weights. The exact weight as now derived from the double cubit cubed is 93·54 pounds avoidupois, or 648,000 O.G.T. or 654,480 G.T.

The following evidence is now brought forward from the monuments.

1. From the content and bulk of the Pyramid Coffer.

2. From the comparison of the cubes of all cubits given in "Inductive Metrology," which comparison I term "the Quadrilateral."

3. From the collation of several evidences arranged in one table.

Pyramid Coffer Cubit.

In the "Ancient Cubit" (1903) I gave an account of the Pyramid Coffer, showing that it was so constructed that its ends, sides, bottom, and bulk were in the proportion of 2, 3, 4, and 9, and that the total bulk was that of the double cubit cubed, and that the measure of the interior likewise harmonized. I proposed a theory of construction from which I deduced all its measurements, and compared them with those taken independently by Messrs. Smythe and Petrie from actual measurements. I had not then discovered that there was a special *coffer cubit* (648 C.I.), and without the aid of that cubit I could only approximate the capacity of the coffer as 72,333·3̇ C.I. instead of 72,576 C.I. as now deduced.

Before explaining this subject, I will first show that the measurements obtained by taking multiples of the *coffer cubit* synchronize one with another, and with the double cubit cubed, and that the *coffer cubit* itself, when cubed, is $\frac{1}{108}$ of the double cubit cubed. In the first column I show the various bulks given by Professor Petrie, and in the second column those I have deduced by theory of construction (explained in the "Ancient Cubit").

	From Measurements by Petrie.	By Theory of Construction. Coffer Cubits Cubed.		Proportion.
	C.I.	C.I.	No. of Coffer Cubits Cubed.	
Bulk of Coffer: ends and sides	46,667	46,656	72 (× 648 C.I.)	2
,, ,, bottom ...	23,830	23,328	36 ,,	1
Bulk of stone	70,500	69,984	108 ,,	3
Interior space	72,030	72,576	112 ,,	$3\frac{1}{9}$
Volume over all	142,530	142,560	220 ,,	$6\frac{1}{9}$

Professor F. Petrie says of his measurements: "There is a good deal of rough work, however, in the hollowing-out of the interior of the Coffer, and the best test is the comparison of the external dimensions."

It will be seen in the external dimensions there is only a difference of 3 C.I. in 14,253, showing that the cubit cubed of 648 C.I. exactly suits the average of Petrie's bulk measurements. It will now be seen that for linear measurements the Coffer cubit is equally suitable.

Coffer cubit = $\sqrt[3]{648}$ C.I. = $6\sqrt[3]{3}(= 1{\cdot}44225) = 8{\cdot}6535$ inches.

		Measurements by Petrie.	By Theory of Construction.	Number.
		Inches.	Inches.	
Interior space of Coffer	Length	78·08	77·881	9 Coffer cubits.
	Breadth	26·85	26·922	$3\frac{1}{9}$,, ,,
	Depth	34·43	34·614	4 ,, ,,
Volume over all ...	Length	89·62	89·419	$10\frac{1}{3}$,, ,,
	Breadth	38·50	38·460	$4\frac{4}{9}$,, ,,
	Depth	41·31	41·536	$4\frac{4}{5}$,, ,,
Dimensions added for comparison		308·79	308·843	
Thickness of stone ...	Sides	5·89 5·67	5·76 —	$\frac{2}{3}$,, ,,
	Bottom	6·89	6·92	$\frac{4}{5}$,, ,,

By adding up all the dimensions in each column the difference is only 5 in 30,884, so that the Coffer cubit exactly fits the measurement, and must be accepted as correct.

The Pyramid Coffer is a stone box, without a lid, with sides $\frac{2}{3}$ cubit thick, bottom $\frac{4}{5}$ cubit thick, and an interior space of the following dimensions: Length 9 cubits, breadth $3\frac{1}{9}$ cubits, and depth 4 cubits, giving a space of 112 cubits cubed. Note that if the breadth had been 3 cubits instead of $3\frac{1}{9}$, the interior space would have been 108 cubits cubed. The bulk of the stone box is 108 cubits cubed. Thus, the volume over all is 220 cubits cubed.

Now, 108 Coffer cubits cubed = the Pyramid double cubit cubed of 69,984 C.I., or 27 Babylonian cubic feet or 40·5 British cubit feet, and the interior space is $\frac{1}{27}$ more, or 28 Babylonian cubic feet, or 42 British cubic feet.

I will now show how the architect of the Coffer calculated his dimensions:

He had a difficult task to perform, and one which could not come out absolutely correctly with the fractions available.

The task was as follows: The bulk of the stone Coffer was to be the content of the double cubit cubed (69,984 C.I.), with the content of the short sides, bottom, and long sides in the proportion 2, 3, 4, to the content 9. The interior space is $\frac{1}{27}$ more than the double cubit cubed (or 72,576 C.I.). It works out practically as follows:

Description.	Coffer Cubits Cubed.	In Practice.	Coffer Cubits Cubed.
Two long sides, in theory $\frac{4}{3} \times 9 \times 4$	48	$\frac{4}{3} \times 9 \times 4$	48·0
Two short sides, in theory $\frac{4}{3} \times 4{\cdot}5 \times 4$	24	$\frac{4}{3} \times [(3\frac{1}{9} + \frac{4}{3}) = 4\frac{4}{9}] \times 4$	23·7
Bottom, $\frac{2}{3}\frac{4}{1} \times 10\frac{1}{3} \times 4{\cdot}5$...	36	$\frac{4}{5} \times (9 + \frac{4}{3}) \times (3\frac{1}{9} + \frac{4}{3})$	36·7
	108		108·4

There is thus an extra bulk of $\frac{69984}{270} = 259{\cdot}2$ C.I. to dispose of, which could only be got rid of by reducing the thickness of the bottom $\frac{1}{90}$ —that is to say, by reducing the thickness of the bottom from $\frac{4}{5}$ to $\frac{71}{90}$ inch. This error was probably discarded as too small.

If we now accept the bulk of Coffer, and sides, and bottom

at their theoretical values in cubic cubits (of 648 C.I.), we shall see that these portions of the stone Coffer represent certain proportions of the double cubit cubed which were used in all the measures of capacity of the Old World until long after the Roman period (including the Hebrew measures).

COFFER.

			Proportion.	Content in Logs.	Derived Cubits.
					Inches.
Bulk { Long sides :	31,104 C.I.	=10 Talmudic talents	12	96	21·895
Bulk { Short ,,	15,552 ,,	10 Solonian or Attic talents ...	6	48	17·376
	46,656 ,,	10 Royal talents (cubic yard) ...	18	144	25·045
Bottom	23,328 ,,	10 Assyrian talents (or Artabas)	9	72	19·893
	69,984 ,,	The double cubit cubed	27	216	41·222
$\frac{1}{27}$ Bulk	2,592 ,,	The Babylonian talent		80	20·611
Coffer cubit cubed	648 ,,	24 rovised Hon		20	8·6535

The height of the interior of the Coffer is 4 Coffer cubits: if this be divided into twenty-one parts and one part be measured down from the top, a *ledge* will be found which marks the Euboic measure—that is to say, the whole content is 42 British cubic feet, but from the bottom to the level of the ledge is 40 cubic feet or 32 bushels. We have now the various Coffer measurements:

	Proportion.	Bushels.	British Cubic Feet.	Babylonian Cubic Feet.	Coffer Cubic Cubits.	C.I.	Radius and Height of Cylinders.
Euboic measures ...	80	32·0	40·0	$26\frac{2}{3}$	$106\frac{2}{3}$	69,120	28 inches
Bulk outside	81	32·4	40·5	27	108	69,984	—
,, interior... ...	84	33·6	42·0	28	112	72,576	4 Pyramids
,, over all	165	66·0	82·5	55	220	142,560	—

THE INTERIOR SPACE.

The interior space is equal (nearly) to 4 Pyramids of 44 inches base and 28 inches height. Interior space 72,576 C.I.; 4 Pyramids (18,064 C.I.) 72,256 C.I.

THE QUADRILATERAL OF CUBITS.

I discovered the existence of the quadrilateral in the following manner: I cubed the means of the several series of cubits

taken from buildings given in Professor F. Petrie's "Inductive Metrology," and found that the contents of the foot talents could be resolved into two series of six each, in the proportions 36, 48, 54, 72, 80, 96, and 144, and that the unit in one case is the Babylonian log or mina of 32·4 C.I., and in the other case it is the Gudean dry measure of 40 C.I. (the Persian Mudd).

Subsequently, I found another series in the bulks of portions of the Pyramid Coffer cubit cubed and the Khar, and, eventually, I found the fourth system in cubed cubits of later times in a series of 48, 54, 72, and 80 units of 32 C.I., thus completing the quadrilateral as follows:

Liquid, Pyramid log, 32·4 C.I., reduced as 81 : 80 to 32 C.I.
Dry, Gudean, 40·5 C.I., raised as 81 to 80 from 40 C.I.

There is also another series founded on 30 C.I., the old Gudean mina, but it is uncertain whether this is only a coincidence, 1,920 C.I., for example, being 48×40 and 64×30.

The Ancients appear to have used the cube sides of their measures of capacity as their building cubits. It is also evident that there was a common centre of direction with regard to these two series of cubical contents, founded on such different principles. The quadrilateral cubit of 21·361 is almost identical with the Black cubit of $27 \times \cdot 79012 = 21\cdot\dot{3}$ (geometric) and the quadrilateral Punic cubit of 22·109 is almost identical with the 28-digit cubit of 22 inches (geometric). The various geometric cubits, including Olympic foot and Roman foot, the cubit of a man, and the cubit derived from 1,800 C.I. Gudean do not belong to the quadrilateral.

Age of the Pyramid Coffer.

The Coffer may have been introduced into the Pyramid ages after it was built, possibly at the termination of the Seventeenth Dynasty when the Artaba came into use.

TABLE V.

The Quadrilateral.

Note.—The cube root of the content or talent gives the foot from which the cubit is derived.

Inductive Metrology.			Deduced Sextarial Measures (Liquid).				Gudean	Deduced Late Assyrian (Pseudo-Euboic).			
(No. 1.)	Petrie's Mean Cubits.	Cubic foot. C.I.	Cubic foot. C.I.	Foot Inches.	Cubit Inches.	(No. 1.)		Cubic foot. C.I.	Foot Inches	Cubit Inches.	(No. 4.)
1	—	—	32·4	—	—	—	30	32	—	—	—
48	—	1565·0	1555·2	11·584	17·376	Solonian foot	1,440	1,536	11·53	17·306	Persian (late)
54	18·21	1789·0	1749·6	12·05	18·075	Greek foot	1,620	1,728	12·00	18·00	British foot
72	20·00	2368·6	2332·8	13·262	19·892	Assyrian Great U Bath. Artaba	2,160	2,304	13·207	19·81	Drusian foot
80	20·63	2617·4	2592·0	13·741	20·611	Babylonian cubit	2,400	2,560	13·68	20·52	Naukratis
96	21·68	3023·4	3110·4	14·597	21·895	Assyrian, Talmudic foot, Plinian foot	2,880	3,072	14·537	21·805	—
144	25·10	4691·0	4665·6	16·709	25·045	Persian, Royal foot	4,320	4,608	16·64	24·96	—
640	—	—	20736·0	—	—	—	—	69,120	—	—	Double cubit cubed
2,164	—	—	69984·0	27·482	41·22	Doubled cubit cubed					

(No. 2.)			Gudean Corn Measures.			(No. 2.)	Sextarial Measures (Corn).			(No. 3.)
1	—	—	40	—	—	—	40·5	—	—	—
36	16·88	1,427·6	1,440	11·29	16·938	Aratni	1458·0	11·253	16·88	—
48	18·63	1,917·8	1,920	12·476	18·714	(late Assyrian)	1944·0	12·48	18·72	Babylonian Foot
54	19·13	2,067·8	2,160	12·926	19·389	Bushel cubit, Pythic double foot	2187·0	12·98	19·47	¾ Pyramid Coffer cubit
72	21·38	2,887·6	2,880	14·241	21·361	Moslem Black cubit	2916·0	14·280	21·42	—
80	22·31	3,288·4	3,200	14·736	22·109	Punic foot, Prehistoric foot	3240·0	14·79	22·19	—
144	—	—	5,760	—	—	—	5832·0	18·00	27·00	Early cubit (Khar)
—	—	—	69,120	—	—	Double cubit cubed	69984·0	—	—	Double cubit cubed

TABLE VI.

Collation of Evidences.

If the various classes of evidence be collated, it will be seen that in later times there was considerable variation in the proportions of units in use, but that the Bath of 72 logs was adhered to all round.

Sextarial Measure.				Bulk of Portions of Pyramid Coffer.	Inductive Metrology. Cubits Cubed.	Late Gudean.
Old.	Late. — 32·4 C.I.	Number.	Late Roman and Grecian. — 32·4 C.I.	32·4 C.I.	32·4 C.I.	Dry. 40 C.I.
—	Log	1	Sext	—	—	Mudd
Ka	Cab	4	—	—	—	Sa
—	—	6	Congius	—	—	Makuk
—	Hin	12	—	—	—	Fuk
—	—	16	Modius	—	—	Wæba
Bar	Seah	24	—	—	—	,,
—	—	36	—	—	Aratni	—
—	—	48	Amphora	$\frac{1}{10}$ short sides	= Solonian cubic foot	Khafiz
As	Bath	72	Metretes	$\frac{1}{10}$ bottom	= Assyrian Great U cubic foot	Artaba
—	—	80	—	—	= Pyramid cubic foot	—
—	—	96	Medimnus	$\frac{1}{10}$ long sides	= Talmudic cubic foot	—
Pi	—	144	—	$\frac{1}{10}$ all sides	= Royal cubic foot	—
—	—	216	—	$\frac{1}{10}$ bulk	—	—
Gur	Kor	720	—	—	—	—
—	—	960	Culeus	Long sides	—	—
—	—	1,440	—	All sides	—	—
—	—	2,160	—	Bulk	—	—

Early Babylonian Measures, East and West.

Table VII. gives the early measures and the reversion to pseudo-Euboic measures in later times.

The Bath, or sextarial Artaba of 2332·8 C.I., is the principal unit for Western Babylonia, and the bushel of 2,160 C.I. for Gudean or Eastern Babylonia.

At some unknown date there was a revolt in Western Babylonia against the sextarial measures, and a reversion as 81 : 80 to pseudo-Euboic measures.

At some period also, date unknown, the wet Gudean mina of 30 C.I. was converted into the pseudo-Euboic mina of 32 C.I. (8,000 O.G.T.). These changes have been arrived at inductively.

Of the existence of the sextarial Artaba of 2332·8 C.I., there is abundant proof ("Encyclopædia Brittanica," Weights and Measures, gives 2,336 C.I.). Of the existence of the pseudo-Euboic mina of 8,000 O.G.T., there are the weights of 7,992 O.G.T., brought back by Mr. Layard from Nineveh (Madden's "Jewish Coinage"), and the 80 O.G.T. standards of Naukratis and Tanis (F. Petrie). Proofs of the values of the Gudean pound (30 C.I.) are given on page 28.

TABLE VII.

		West Babylonia.		East Babylonia (Gudean).		
		Early Assyrian (Sextarial). C.I.	Late Assyrian (Euboic). C.I.	Wet. C.I.	Dry. C.I.	
—	Karsha	0·54	—	— [3 4] —		
1	Log	32·4	32	30	40	
4	Cab	129·6	128	120	160	
12	Hin	388·8	384	360	480	
24	Seah	777·6	768	720	960	
72	Bath	2332·8	2,304	2,160	2,880	All in quadrilateral
80	Cubic foot talent	2592·0	2,560	2,400	3,200	
96	Talmudic cubic foot	3110·4	3,072	2,880	3,840	Fanega of Spain
144	Pi	4665·6	4,608	4,320	5,760	
720	Gur, Cor ...	23328·0	23,040	21,600	28,800	
2,160	Double cubit cubed	69984·0	69,120	—	—	

Weights.

Amongst primitive people, far away from the civilized centre of the Euphrates Valley and Egypt, the Ganda system, or multiple by fours, held its own, even to the present day, as in India and in Europe.

For example, a medieval English weight system gives 16 ounces to the pound, 16 pounds to the stone, 16 stones to the wey of $\frac{1}{10}$ double cubit cubed.

In other parts the more recent system of 64 pounds to the talent prevails, as in 64 pounds (of 27 C.I.) to the cubic foot of 1,728 C.I. Again, in other parts we have 80 pounds and 100 pounds to the talents of 2,160 and 2,592 C.I., and 2,304 C.I. and 2332·8 C.I.

But in civilized parts the division of the talent into sixty minas prevailed, and both the bushel and the Eginetan talent were divided into 60 minas, 6,000 drachmas, and 60,000 oboli; whilst the Gudean talent was divided into 60 minas, 1,800 shekels or cubic inches of water, and 3,600 darics.

In later times there was an increase of some talents in Egypt as 15 : 16, and a reduction as 81 : 80, and in process of time other changes.

During the Roman Empire the pounds in use were reduced from 100 to 96 drachmas, the drachma remaining the same.

Table VIII. gives all the talents with their variations to the time of the Roman Empire.

The Shekel.

There have only been six kinds of shekel, of which three are almost identical:

	O.G.T.
(1) The original shekel of 128 Rati	216·0
(2) The commercial Euboic	180·0
(3) The shekel of 4 Attic drachmas	259·2
(4) The same reduced as 81 : 80 (late)	256·0
(5) The weight of 1 cubic inch of water (Gudean)	250·0
(6) Phœnician (late Gudean) $\frac{9}{10}$ of No. 5 ...	225·0

The Kat of 135 O.G.T. has not been classed as a shekel: it ran to 144 O.G.T. with the Troy talent, and was a common small weight in Egypt in late times.

Assyrian Talent (75 Troy pounds).

From the following we may arrive at the late Assyrian talent, which has already been given in its early form as the 18-inch cylinder, of which the Artaba is 2,304 C.I., and the pound 28·8 C.I., the Miscal Rotl of the Moslems (p. 19, Table III.).

In "Origin of Currency and Weight Standards," p. 183,

TABLE VIII.

Showing all Varieties of Talents (Weights) and their Subdivisions up the Time of the Roman Empire.

	Say 2100 B.C.		Say 900 B.C.	Say 2100 B.C.	
	Octaval. Euboic. O.G.T.	Sextarial. Western Babylonia. O.G.T.	Nineveh. Reversion to Octaval. Western Babylonia. O.G.T.	Eastern Babylonia (Gudean).	O.G.T.
$\frac{1}{6000}$ obol	9	10·8	—	$\frac{1}{10800}$ siglos (silver)	83·3
$\frac{1}{1000}$ drachma ...	54	64·8	64	$\frac{1}{7200}$ daric (gold)	125·0
$\frac{1}{6000}$ drachma (later)	90	108·0	—	$\frac{1}{5400}$ 2 siglos	166·6
$\frac{1}{4000}$ Kat	135	—	—	—	—
$\frac{1}{3000}$ commercial shekel	180	216·0	—	$\frac{1}{4000}$ late shekel	225·0
$\frac{1}{2500}$ shekel	216	259·2	256	$\frac{1}{3600}$ shekel	250·0
$\frac{1}{100}$ pound	5,400	6480·0	6,400	$\frac{1}{120}$ light mina	7500·0
$\frac{1}{80}$ commercial pound	6,750	8100·0	8,000	$\frac{1}{60}$ heavy mina	15000·0
$\frac{1}{60}$ mina	9,000	10800·0	—	$\frac{1}{2}$ light talent	450000·0 (1,800 C.I.)
$\frac{1}{50}$ double pound ...	10,800	12960·0	12,800	1 heavy talent	900000·0 (3.600 C.I.)
1 talent	(2,160 C.I.) 540,000	(2,592 C.I.) 648000·0	(2,560 C.I.) 640,000		
				—	500000·0 (2,000 C.I.)
				—	750000·0 (3,000 C.I.)
$\frac{1}{3600}$ late obol ...	15	18	—	$\frac{3}{4}$ heavy talent	675000·0 (2,700 C.I.)
$\frac{3}{4}$ talent	(1,620 C.I.) 405,000	(1,944 C.I.) 486000·0	(1,920 C.I.) 480,000		
Troy $\frac{10}{15}$ talent ...	(2,304 C.I.) 576,000	(1,555·2 C.I.) 388,800	(1,600 C.I.) 400,000		
$\frac{4}{5}$ Talent	(1,728 C.I.) 432,000	(2,332·8 C.I.) 583,200	(2,304 C.I.) 576,000		

attention is called to a duck weight in the Louvre Museum, marked in Assyrian as $22\frac{1}{2}$ grains, weighing $14\frac{6}{7}$ grains Troy, and assumed to be $\frac{3}{4}$ Obol. And the following table is given, to which I have added the weight on the supposition that $14\frac{6}{7}$ grains Troy should be 15 G.T. The grain used was in common use viz.: $\frac{2}{3}$ O.G.T.

From "Origin of Currency," etc.	Assyrian Grains.	O.G.T.
$22\frac{1}{2}$ grains $=\frac{3}{4}$ obol	$22\frac{1}{2}$	15
30 grains =1 obol	30	20
6 obols =1 drachma	180	120
2 drachmas =1 shekel	360	240
10 drachmas =1 stone	1,800	1,200
60 drachmas =1 light mina	10,800	7,200 (Miscal Rotl)
60 minas =1 talent	648,000	432,000

This talent is the weight of an Imperial cubic foot of water. This Assyrian grain runs 10,125 to the Hon of 27 C.I.

The grains mentioned in this Chapter are:

Rati	4,000 to Hon of 27 C.I.			
Ancient wheat	8,000	,,	,,	
,, barley	6,000	,,	,,	
Assyrian ...	10,125	,,	,,	800 B.C. to 500.
Late Babylonian	10,000	,,	,,	500 B.C. to —
Troy wheat ...	9,000	,,	,,	
,, barley ...	6,750	,,	,,	

The Egyptian Kat.

We have now to consider the subject of the Egyptian Kat (80 Rati), which in early times was 136 G.T., but in later years increased in weight to 145·4 G.T., and has come down to us in late times in the Cairo Moslem Rotl of 6,912 O.G.T., or 48 Kat of 144 O.G.T.

We may trace the existence of this Kat of 40 to the Troy pound up to recent times.

Kelly's "Cambist" (1824) gives the Cairo ounce of 576 G.T., which equals 4 Kat of 144 G.T.

Dr. Arbuthnot, 100 years ago, gives the Rotl of Cairo at 144 drams of 48 G.T., which is 48 Kat of 144 G.T.

Professor Greaves, 250 years ago, gives the same of the Alexandrian Rotl.

Queipo cites Makrisi and Mahomed Sephad (of seventh century), to show that the Moslem pound was 144 drams of 64 grains (64 grains = 48 G.T.).

We have here again an indication of the transformation that took place :

	O.G.T.			O.G.T	
The Kat	135	raised by $\frac{1}{15}$	to	144.	
Tower pound	5,400	„	„	5,760 = 40	Kat, Troy pound.
Attic „	6,480	„	„	6,912 = 48	Kat, Cairo Rotl.

The question now arises as to when this change took place. In history we only know of the Troy pound, so far back as the time of Khalif Almamun, A.D. 814.

The Addition to the Old Pounds of $\frac{1}{15}$ their Weight (Tables IX. and X.).

I give two tables. No. IX. shows how the old pounds of 6,750 O.G.T. (the Hon), 5,400 O.G.T. (the Tower pound), and 6,480 O.G.T. (the Attic pound), may have been raised by $\frac{1}{15}$, together with their commercial relatives, the pounds of 16 ounces, and the parts of Europe they were common to before the introduction of the metrical system.

It will be seen from the table that the raised pounds have only been found in the civilized world of the Roman period, while the old pounds have been found amongst the Gothic or Barbarian races, and that there are further distinctions.

North of a line drawn from the mouth of the Rhine through Holland, Switzerland, to Venice, the old pounds were to be found. The Tower pound had its habitat in Germany and Northern Italy, while the Attic pound was found in Poland, West Austria, and West Russia, suggesting two distinct races or kingdoms.

South of the line the Troy pound was found in France, Holland, part of Switzerland, and North Italy, while the Roman pound was found in Southern Italy, up to Florence, Rome, Spain, and Portugal.

It might be reasonable to assume from this that the change

was made under the Roman Emperors, were it not that there is another method by which some of these pounds may have been arrived at, which I show in Table VIII.—viz., by taking for the pound 96 drachmas instead of 100 of the old pound. This, however, we may be certain of as having taken place when Rome became intimately acquainted with the measures of Egypt, between 150 B.C. and 50 B.C. It may be, perhaps, safe to assume that the adoption of the raised Tower pound, making the Troy pound, took place throughout the Roman Empire at the time when the division of the talent into 64 pounds gave way to the sexagesimal division, thus increasing the pound by $\frac{1}{15}$ and the talent remaining the same.

TABLE IX.

To show how the Original Mina and Pounds have at some Period been Raised by Adding $\frac{1}{15}$ of their Weight, at the same time that the Weight of the Grain was changed from $\frac{2000}{9}$ to 250 to the Cubic Inch.

		Rati.	Ancient Grains.	Old Grains Troy.	Old Grains Troy raised $\frac{1}{15}$.	Ounces in Pound.	Remarks.
Purana ...	I	32	48	54	57·6	—	
	II	80	120	135	144·0	—	The Kat or Kharsha.
Euboic ...	III	4,000	6,000	6,750	7200·0	—	Moslem Miscal Rotl.
		—	8,000	9,000	9600·0	—	See Naukratis and Tanis.
	IV	3,200	4,800	5,400	—	12	Tower pound. All Germany, England, Denmark, E. Switzerland, N.E. Italy, including Venice.
Half Eginctan mina ...	V	—	—	7,200	—	16	
		—	—	5,400	5760·0	12	Troy pound. France, England, Holland, W. Switzerland, N. Italy to Turin.
		—	—	7,200	7680·0	16	
	VI	—	—	4,860	—	12	Byzantine and Attic pound.
		—	5,760	6,480	—	16	Poland, W. Austria, W. Russia.
Attic mina ...		—	—	4,860	5184·0	12	Roman pound. Spain, Portugal, South Italy, Rome and Florence.
	VII	—	—	6,480	6912·0	16	
		—	—	—	6912·0	—	The Moslem Cairo Rotl.
	VIII	—	—	7,500	—	—	The Gudean single mina. Babylonia.
		—	—	7,500	8000·0	—	80 standard. Naukratis, Babylon, Nineveh.

The Troy pound is the Rotl of the Khalif Almamun of Bagdad, A.D. 814.

TABLE X.

To show how the Pounds raised by $\frac{1}{15}$ of their Weight may also have been Obtained from other Pounds by Lowering them from 100 to 96 Drachmas.

A.G.	O.G.T. 100	O.G.T. Lowered 96.	Distribution.	O.G.T. Raised 16.	O.G.T. 15.	C.I.
4,800	5,400	—	½ Babylonian mina. North of line of Roman civilization in Middle Ages	—	5,400	1,728
—	7,200	—		—	7,200	
4,800	5,400	5,184	Roman pound. Spain and Portugal, S. Italy, Rome, Florence	5,184	4,860	1,555·5
—	7,200	6,912		6,912	6,480	
—	4,860	—	Attic mina. Poland, W. Austria, W. Russia	—	4,860	Attic.
—	6,480	—		—	6,480	
—	6,480	6220·8	Pound of Seleucidæ in Persia ...	Nil	—	—
—	—	—	Nineveh, Naukratis. Babylonia	6,000	5,625	1,800
—	—	—		8,000	7,500	Gudean.
—	6,000	5,760	Troy pound	5,760	5,400	½ Babylonian.
—	8,000	7,680	Scotch pound	7,680	7,200	,,
—	7,500	—	Gudean or Olympic pound... ...	—	7,500	Gudean.
—	7,500	7,200	16 ounces Troy	7,200	6,750	Euboic.
—	6,750	6,480	Attic pound	—	6,480	Attic.
6,000	6,750	—	The Hon	—	6,750	Euboic.
—	—	—	Found at Naukratis, in Egypt ...	9,600	9,000	Euboic.

TABLE XI.

Weights found at Jerusalem. To show how they have Developed from Ancient Pounds (*P.E.F.Q.S.*, 1870, p. 330).

I.	G.T. II.	G.T. III.	G.T. IV.	16 : 15		A.G. VII.	Kats. VIII.	Drams 40 O.G.T. IX.	X.
				O.G.T. V.	O.G.T. VI.				
	7,253	+ 19	7,272	7,200	6,750	6,000	50	150	—
*	5,698	+119	5,817	5,760	5,400	4,800	40	120	—
	5,674	+133							
	2,891	+ 17	2,905	2,880	2,700	2,400	20	60	—
	3,049	- 19	3,030	3,000	2,812·5	2,500	—	—	—
	2,321	+105	2,424	2,400	2,250	2,000	—	—	—
*	1234·5	- 22·5	1,212	1,200	1,125	1,000	—	—	—

* Hebrew inscriptions.

The Jerusalem Weights.

We are now in a position to consider the bearing the Jerusalem weights have on the subject.

Of the several weights found in the excavations (1867-69) there are six which may be considered in perfect order and nearly up to full weight. These, when tested by me (see p. 336, P.E.F. "Quarterly Statement," 1870), appear to fall into two series of three weights each, the series having a ratio to each other of 12 : 5, and the three in each scale having the ratio to each other of 5, 4, 2. It may be purely accidental these two series having the same ratio, but we take them as we find them (see Table XI.).

I give the actual weights in column II., and the several corrections I have made bring the weights to what I believe to be the correct standard. The correction to each is very small; in four cases it is not 0·5 per cent., in one case 2 per cent., and in the extreme case 5 per cent.

In column V. I apply the correction of 1 per cent. to all the weights to bring them to old grains Troy, and we now find the weights in the following order: 7,200 O.G.T., the commercial raised pound, 16 ounces of the Troy pound, 5,760 O.G.T. the Troy pound, and 2,880 O.G.T. half the Troy pound. So here we have, for certain, weights of the Troy pound with Hebrew inscriptions.

In the second series we have weights of 3,000, 2,400, and 1,200 O.G.T., $\frac{5}{12}$ of the first series, and subdivisions of the late 1,920 C.I. talent.

In column VI. I show all these weights lowered by $\frac{1}{10}$, and in the first series we have the Hon of 6,750, the Tower pound of 5,400 O.G.T., and half the Tower pound.

In the second series we have weights of 2,812·5, 2,250, and 1,125 O.G.T., from which it is clear that they were not used in this condition as grains Troy.

I now, in column VII., turn all the weights from Troy grains to ancient grains, or barley-corns, by multiplying by $\frac{8}{9}$. The first series are, of course, the well-known old pounds and parts in ancient forms.

The transformation of the second series is most interesting;

we have now weights of 2,500, 2,000, and 1,000 grains ancient. So it is evident that this was their original condition before they were raised. They are subdivisions $\frac{1}{80}$ and $\frac{1}{100}$ of the Gudean talent 1,800 C.I. Olympic or Phœnician trade talent.

We may gather, then, from these weights that there were in use in early days weights of 2,500, 2,000, and 1,000 A.G., and that at some time the grain ancient was changed to grain Troy, *and at the same time* the pounds were raised in weight $\frac{1}{15}$ of their weight, and that at this time the Tower pound became the Troy pound, and the Hon became the 7,200 O.G.T. (commercial pound of Central Europe). We have further the certainty that the change took place before the destruction of Jerusalem, and in a time when Hebrew characters were in use. As this weight (28·8 C.I.) existed during the Seventeenth Dynasty (see Chapter I., p. 20), I have to suggest that the change from 15 to 16, in weight, took place about 1914 B.C., at the beginning of the Assyrian Monarchy.

We are now in a position to examine carefully all the weights which have not yet been fully diagnosed, and may be enabled to obtain further interesting information as to the use of the Troy pound in early days. I have no doubt that many of the weights found, in recent years, at Jerusalem, Tel Zakarîya, el-Judeideh, and Gezer, will be found to belong to a system of which the unit is 180 G.T.—*i.e.*, $\frac{1}{8}$ of 10 Egyptian Kats of 1,440 G.T. (3 ounces Troy).

Hebrew.

The Hebrews come very late into the subject of weights and measures. We have no record of the exact measures that they used ; it seems probable that they were Western Babylonian.

The shekel used by the Hebrews in early times (see Tables of Weight, p. 41) was that of the Eginetan talent (216 O.G.T.), divided into 20 Girahs, Greek obols, or Ma'h (see Rabbinical Writings).

They went into captivity, to Babylon, with the Eginetan talent of 2,592 C.I. and 60 shekels to the mina of 12,960 O.G.T. At this time the Babylonians had the pseudo-Euboic talent, just short of the Eginetan, as 80 : 81. Consequently, the Hebrews had to reduce their weight in proportion. But the

pseudo-Euboic talent has no shekel of $\frac{1}{60}$ of a mina, so the Hebrews had to conform and raise their shekel to 256 O.G.T., or $\frac{1}{50}$ mina.

The result is that they went into captivity with a shekel $\frac{1}{60}$ mina, and came out again with $\frac{1}{50}$ mina, as 5 : 6. Probably on their return they reverted to Eginetan measure by adding as 80 : 81.

This accords with the accounts of Josephus and others that in later years the Jewish shekel was 4 Attic drachmas (259·2 O.G.T.).

The Rabbins state that the Jews went into captivity with a shekel of 320 grains and came out with a shekel of 384 grains, as 5 : 6. The explanation is as follows: The Hebrews used the early Assyrian grain (see Table XXXI.), $\frac{2}{3}$ grain Troy, so that the shekel of 216 O.G.T. was 324 Assyrian grains. On arriving in Babylon they had to cast off 4 grains, so as to make it 320, and raise it, as 5 : 6, into 384 Assyrian grains, so as to be $\frac{1}{50}$ of their new mina of 12,800 O.G.T., or 19,200 Assyrian grains. It seems probable that the Hebrews were not permitted to use the Assyrian grain in captivity, as at that time the Troy grain was in use in Babylon.

Linear Measure in the Sexagesimal Period.

The Stade as a linear measure was in use during the Sexagesimal period, when it was reckoned as 100 fathoms, but it seems to have originated at 100 fathoms at a still earlier time, during the Cylinder period.

From the various estimates of the number of Stades in the circumference of the earth given by Greek writers (from 184,000 to 400,000 Stades), it seems in early days to have been subject to considerable variation. Thales, 600 B.C., adopted 400,000 Stades (see writings of Aristotle).

Many Greek writers concur in 250,000 Stades to the earth's circumference, thus giving 6,285·7 inches, or 523·8 feet to the Stade. Now, the 16 divisions, or foot, on De Sarzec's drawing of the cubit of Gudea gives 10·473 inches; and 6,285·7 inches divided by 600 gives 10·476 inches. From this we may infer that in the time of Gudea there were 250,000 Stades of 600 Gudean feet of 10·473 inches each, or 25,000 miles of 1,746 yards each. Each mile 6,000 Gudean feet.

But there are also 160 double cubits of 39·285 inches in 6,285·7 inches. So that we also have 200,000 Stades of 100 fathoms, or 200 double cubits; or 400,000 Stades of 50 fathoms, or 100 double cubits.

The next change was to bring in 360 degrees to the great circle, giving an entirely new cubit.

Aristotle refers to 1,111 Stades to a degree. This number marks the change from the (80) and (100) systems to the (60) system: 400 × 1,000 = 400,000 Stades; 360 × 1,111 = 399,999·9, or 400,000 Stades.

It is thus evident that even in later times Aristotle considered the Stade as 1 by 400,000 of the earth's circumference.

Under the Euboic system, the ancients had divided the quadrant of the great circle into 10,000,000 double cubits of 39·5 inches, and each double cubit into 50 parts, giving a digit of 0·79012 inch.

With the Sexagesimal system of 360 degrees to the circle, and with $(\frac{22}{7})$ in lieu of $(\frac{4}{3})^4$ for π, a new cubit and new digit came into being. The great circle was divided into 2,160,000,000 digits of 0·7275 inch, giving a cubit of 18·1875 and foot of 12·125, called the Greek or Olympic cubit and foot, because we have derived it through the Greeks.

There are a variety of methods of distributing the threes in ascending from the digit to the great circle. For example:

360 degrees of 6,000,000 digits.
10,000 Parasangs of 216,000 digits.
6,250 Parasangs of 345,600 digits.

The system which comes down to us through the Greeks is:

360 degrees of 60 minutes { of 60 seconds of 100 Greek feet. / or of 100,000 digits.

The Greeks gained a multiplier of 3 by making the foot $16\frac{2}{3}$ digits. The Romans had only 16 digits to a foot, and their system ran thus:

360 degrees of 75 miles of 5,000 feet (80,000 digits).
27,000 miles of 5,000 feet.

The Roman foot bore to the Greek foot the ratio of 24 : 25 : : 11·64 : 12·125. There are thus 100 digits to the Greek

fathom, and there would be 96 of the same digits to the Roman fathom, if such an one existed. Apart from this reason for the dimensions here accepted for the Roman foot, the geometric foot of 16 digits (11·64 inches) is almost identical with the average Roman foot of 11·64 inches as deduced by Petrie, Böckh, and other experts.

Babylonian and Greek Sexagesimal Systems.

When the Sexagesimal system came into use, and the circumference of circle was divided into 360 instead of 400 degrees, a new digit was established, but the Sexagesimal system did not extend further than the minute ; below that the Decimal system comes in :

Digit $= (\frac{22}{7}) \times \frac{500000000}{360 \times 60 \times 100000} = 0{\cdot}7275$ inch. This digit was common to the Greek and Roman foot.

TABLE XII.

	Babylonian and Greek Digits.	Digits in Imperial Inches.	Greek Feet.	$\frac{22}{7} = \frac{3{\cdot}1428}{15{\cdot}714}$
Digit ...	1	0·7275	—	—
Foot ...	$16\frac{2}{3}$	12·1250	1·0	—
Cubit ...	25	18·1875	1·5	—
Fathom ..	100	72·75	6·0	—
Second ...	1,666	1212·5	100·0	—
Stade ...	10,000	7275·0	600·0	—
Minute ...	100,000	72750·0	6000·0	Decimal System to this point for digits.
Degree ...	6,000,000	4365000·0	360000·0	—
Circumference	2,160,000,000	1571428571·0	129600000·0	Sexagesimal System.

Babylonian, Assyrian, and Persian Transitional Sexagesimal Systems.

The following are the systems of linear measure which appear to have existed in Babylonia, Assyria, and subsequently in Persia, founded in early times on the digit 0·79012 inch, with a double cubit of 39·5 ; and at a later period with the digit 0·78571 inch founded on the double cubit 39·28. The Assyrian cubit came in at a later date, and seems to be based on the Black cubit of $21\cdot\dot{3}$ inches, 27 digits of 0·79012 inch, which

nearly equals the late Assyrian building cubit of 21·37 inches ("Inductive Metrology," p. 67). There is no record of the Assyrian Great U of 19·892 inches having been used for linear measure.

TABLE XIII.

Babylonian and Persian.			Babylonian (Sex.), Early.			Assyrian, Late.	
	Cubit.	Inches.		Double Cubit.	Inches.	Foot.	Inches.
Digit $\frac{1}{360}$ 39·285 inches.		Value of π $(\frac{22}{7})$			Value of π $(\frac{4}{3})^4$	$\frac{1}{600}$	0·17
Digit ...	$\frac{1}{432}$	0·78571	Digit ...	$\frac{1}{600}$	0·79012	$\frac{2}{277}$	0·79012
Cubit ...	1	25·14	Cubit...	—	19·75	$\frac{1}{3}$	3·$\dot{5}$
Reed ...	6	150·08	2 Cubits	1	39·50	1	10·$\dot{6}$
						2	21·$\dot{3}$
Stade ...	360	9051·42	Reed ...	6	237·00	6	64·0
—	10,800	27154·0	Gur ...	12	474·00	12	128·0
Kasbu ...	21,600	54306·5	Ush ...	720	26440·00	720	7680·0
—	—	—	Kasbu	21,600	793208·00	2160	230400·0
Parasang ...	10,000	251428·000	2 Kasbu	43,200	1596417·00	—	—
Circumference of the world = 6,250 Parasang.							

The two medieval Moslem systems of linear measure appear to be based on these two Babylonian systems, and are taken from the metrological work of Don Vasquez Queipo, except that I use the old digit (0·79012 inch), whilst he uses a digit of 0·0205 metres (0·78936 inch). It will be seen that the Black cubit is used, and 3 Black cubits = 64 inches. The Balady cubit is evidently $\frac{1}{10000}$th Parasang: its origin is doubtful.

TABLE XIV.

Hachemic System.				Khalif Almamun's System.				
	Digit.	Cubit.	Inches.	Name.	Gudean Cubit.	Cubit.	Digit.	Inches.
Digit ...	1	—	0·79012	Digit ...	—	—	1	0·79012
Foot ...	16	—	12·64	Foot ...	—	—	18	14·$\dot{2}$
New cubit	24	—	18·96	Gudean cubit	1·0	—	25	19·75 (Early)
Balady (New)	28·8	—	22·75	Black cubit	—	—	27	21·$\dot{3}$ (Early)
Hachemic (Early)	32	1	25·28	Rasashia cubit	—	1	36	28·$\dot{4}$ (New)
Kasib ...	192	6	151·70	Kasib ..	7·2	5$\dot{0}$	180	142·$\dot{2}$
Ghalva ...	11,520	360	9102·2	Mile ...	3600·0	4,000	90,000	71111·$\dot{1}$
Mile ...	96,000	3,000	75851·0					
Parasang ...	288,000	9,000	227555·0					

The Individuality of the Cubit.

The cubits made use of in early days are for the most part distinct; they do not merge one into the other, and except in one case they cannot be mistaken one for another. Seven of them are derived from the measurement of arcs of the meridian, and nine are the cube roots of cubic and cylindric capacities, containing weights of water which have a relative proportion one to another.

TABLE XV.

Cubits derived from an Arc of the Meridian.			Cubits derived from Contents of Cylinders or Cubes.			
	Cubit.	Digit.		Cubit.	Talent.	Date.
	Inches.	Inches.		Inches.	C.I.	
$(\frac{1}{3})^4$ for π ...	39·50617	$=50\times0{\cdot}7901234$	The Khar cubit	27·00	5,832	4th Dynasty
	25·0	$=\frac{3}{2}\frac{2}{5}\times$,,	Pyramid cubit	20·61	2,592	,,
Assyrian (Late)	21·3	$=27\times$,,	Cubit of a man	17·66	—	,,
			$\frac{6}{10}$ Pyramid cubit	12·36	—	,,
			Assyrian Great U	19·892	2332·8	Abu Shehrein
$(\frac{22}{7})$ for π ...	39·285	$=50\times0{\cdot}7857$	Royal	25·045	4665·6	4th Dynasty
Punic (Late)	22·0	$=28\times$,,	Talmudic (Late)	21·895	3111·4	Late
			Euboic (bushel)	19·389	2,160	Vulnirari I.
Olympic $(\frac{22}{7})$	18·187	$=25\times0{\cdot}7275$	Eighteen inch	18·00	1,728	B.M. Bir.
	11·64	$=16\times$,,	Drusian foot (very Late)	19·81	2,304	Late.

In addition are the Prehistoric cubits (see Chapter IV.).

The Overlaps of the Cubits.

The only case in which cubits can be mistaken is where the Olympic or Roman foot overlaps two building cubits: on the one side the Pyramid cubit and on the other side the 18-inch measure. A table is given of the overlaps and the proposed disposal of the digits, 0·72 to 0·75 inch (see "Inductive Metrology," p. 55).

In consequence of these overlaps there are several digits in Inductive Metrology which are not located. In the following examination, I have endeavoured to locate them:

	Digit.	Foot.	Cubit.	Cubit.	Where Found.
	Inch.	16 Digits.	24 Digits.	25 Digits.	
18-inch measure ...	0·72	11·52	17·28	18·00	0·721 Moab. 0·72 Etruscan Greece. 0·722 11·52 Italy, Pelasgic.
Attic talent, Roman Amphora	0·7235	11·58	17·36	—	0·7252
Sexagesimal geometric cubit	0·7275	11·64	17·46	18·18	0·728
Olympic	0·728	11·65	—	—	11·66. 0·7296. 0·730.
Pyramid cubit 20·52 ...	0·7329	11·7262	17·589	—	0·733 Syria and Asia Minor. 7·339.
Pyramid cubit 20·61 ...	0·7360	11·776	17·66	—	0·7339
Pyramid cubit 20·68 ...	0·7380	11·808	17·71	—	0·7387
Pyramid 27	0·7500	12·000	18·00	—	0·749 Egypt. 0·75 England.

Order of Sequence of the Building Cubits.

I have endeavoured in Table XVI. to give the building cubits recorded by Professor F. Petrie (in "Inductive Metrology") in order of sequence. In doing so I venture to show some of the portions of cubits as parts of the 27 and 45 inch cubits not hitherto recognized.

TABLE XVI.

TABLE SHOWING THE SEVERAL BUILDING CUBITS MENTIONED IN "INDUCTIVE METROLOGY," IN ORDER OF ORIGIN AND THEIR PROBABLE ORIGIN. THERE IS NO BUILDING CUBIT EARLIER THAN THE FOURTH EGYPTIAN DYNASTY.

		Standard Cubit.	Cubits and Parts, from Professor F. Petrie's "Inductive Metrology," in Inches.								
		Inches.	Egypt.	Assyria.	Persia.	Syria.	Asia Minor.	Greece.	Italy.	Africa. Sardinia.	Britain.
From double cubit		27·0	0·453 27·18 0·676 27·06	—	—	—	1·885 —	1·131 —	—	—	—
				—	—	— 45·66	— 45·24	— 45·24	0·75 —	—	—
Cubit (earliest form)		45·0	0·750 27·00	—	—	—	— 22·56	—	— 45·24	—	—
			1·736 27·00	—	—	1·427 —	—	—	—	—	—
From Pyramid Coffer.	Pyramid cubit ...	20·61	— 20·64	—	1·730 —	—	17·25 20·64	12·4 —	—	7·32 —	— 12·4
			1·547 20·63	— 20·68	— 20·76	— 20·73	0·733 20·51	— 20·67	— 12·45	—	—
			0·733 20·68	—	—	—	—	—	—	—	—
	Assyrian cubit Great U	19·89	—	— 19·97	—	0·404 —	3·994 —	—	1·99 —	—	0·99 19·99
						— 20·24	— 19·97	—	— 19·96	— 20·08	7·96 19·9
	Royal cubit	25·04	2·11 16·89	— 25·28	1·01 16·88	—	—	—	—	—	—
					— 25·32	— 25·20	—	2·53 —	—	—	—
			0·502 25·10		— 25·34	—	—	— 25·38	—	—	—
	Aratni	16·7			— 16·49	—	—	—	—	—	—
					—	—	—	—	—	—	—
	Talmudic cubit ...	21·89	—	—	—	—	— 10·91	—	—	— 10·8	— 14·59 — 21·88

Pyramid Bushel Cubit.	Sextarial Pyramid ...	19·47	— — — 18·92 — 9·46	— 1·18 — — 19·24	— — —	— — —	— — —	— — 6·42 — 19·30	— — —	1·89 9·62 — 19·24 — 18·96	— — —
	Sexagesimal Pyramid	19·39	—	—	— 0·765 — — 19·13	— — —	— — — 19·30	— — —	— — —	— — —	— — —
Sexagesimal Geometric ($\frac{22}{7}$).	Olympic	18 18	0·7276 18·24	0·730 — — 18·25	— —	0·727 — — 18·17	— 18·16 — 12·11	— 12·15 — 18·23	— 12·19 —	— —	— — 12·17
	Roman	11·64	—	—	—	— 11·67	— 11·64	— 11 6	— 11·68	— 11·74	— 11·60
Geometrical $(\frac{4}{3})^4$ ($\frac{22}{7}$).	Punic	22·0	—	—	— 0·734 — — 22·0	— 1·113 11·13 —	— — —	— — —	— — —	— 11·16 1·38 11·07 —	— — 4·40 —
	Assyrian (Late) ...	($\frac{64}{3}$) 21·3	— 21·4	— 21·37	— 21·37	—	— —	— —	— 4·27 — 21·37	—	— 21·38 — 21·34
$\frac{2}{3}$ Doublo Cubit Cubed.	West Asia (Late) ...	—	—	—	—	3·30 13·26 3·34 13·12 3·33 13·33	1·79 13·36 — 2·23 —	— 6·63 — 13·36 —	— — 13·45 —	— 13·34 — 13·26 —	— 13·22 — —
	Drusian	13·2	— 13·19	—	—	—	—	—	—	—	—
	British Hasta	18·0	—	—	—	—	— 17·9 — 8·95	— 17·88 —	—	—	0·999 12·0 —
Rude Stone See "Prehistoric Remains."					—	—	—	—	—	—	—

The Variation of the Cubit throughout the Ages.

There has been very little variation. Investigation shows that from the earliest records (Fourth Egyptian Dynasty) to the Roman period there has been usually an *increase* of about 1 per cent. in the length, and that the margin of error on either side of the average does not exceed 1 per cent.

Throughout the whole series of cubits of which there is any record, the greatest discrepancy is not more than 2 per cent. in any case, except in the late Drusian foot. The following list, extracted from "Inductive Metrology," gives the greatest variations:

TABLE XVII.

	Imperial Inches.												
	Geometric.		The Khar.	Pyramid.				Bushel.	Olympic.		Pelasgic.	Drusian.	Late Assyrian.
	$(\frac{4}{3})^4$	$(\frac{22}{7})$		Royal.	Talmudic.	The Cubit.	Great U.		[25	24]			
Lowest Lowest	19·75	19·64	27·0	25·02	—	20·42	19·95	18·95	12·01	—	—	13·14	—
Lowest Highest				25·10	21·70	20·63	19·96	18·96	12·11	11·64	11·43	13·19	21·33
Highest Lowest				25·34	21·46	20·76	20 24	19 30	12·17	11·74	11·58	13·45	—
Highest Highest				25·50	21·46	20·88	20·325	19·34	—	—	—	13·65	—

TABLE XVIII.

Comparison of Talents.

From Don Vasquez Queipo. "Money Weights."		From Double Cubit Cubed.			"Eucyclopædia Britannica."
Names.	Kilos.	O.G.T.	C.I.	Name.	O.G.T.
1. Early Roman ...	35,400	540,000	2160 0	Euboic	—
2. Pharaonic & Hebrew	42,480	648,000	2592·0	Eginetan	—
3. {Rabbinic / Egypto-Ptolomaic}	21,240	324,000	1296·0	½ Eginetan	—
4. Grecian	25,500	388,800	1555·2	Solonian	{465,000 / 774,000 / 387,000}
5. Egypto-Roman ...	33,984	518,400	2073·6	Late Roman	516,000
6. Roman	32,500	516,250	2025·0	,, ,,	—
7. Asiatic and Roman	32,500	500,000	2000·0	Late Gudean	—
8. {Assyro-Phœnician / Egypto-Olympic}	29,362	450,000	1800·0	Phœnician	465,000 (60 Ka)
9. Babylonian	32,666	500,000	2000·0	Persian	—
10. —	—	576,000	2304·0	Artaba	576,000
11. —	—	480,000	1920 0	{Late Assyrian (Table VI.)}	480,000
12. —	—	{400,000 / 405,000}	{1600·0 / 1620·0}	—	400,000 — } differ as 80 : 81
13. —	—	675,000	2700·0	Late Gudean	672,000
14. —	—	14,400	5760 0	,, ,,	14,600

The talents given in "Encyclopædia Britannica" are very late varieties.

Don V. Queipo's values differ about 1 per cent. from those of double cubit cubed.

CHAPTER III

ATTIC, ROMAN, AND MOSLEM WEIGHTS AND MEASURES

The Attic Systems.

The original measures in Greece were the Euboic bushel talent of 2,160 C.I. and its binary subdivisions. Subsequently, influences from the East introduced the division of the talent by 60, resulting in a mina of 36 C.I. (9000 O.G.T.)—see Table VIII.

Solon (*circa* 550 B.C.), for political reasons, desired to bring in measures more akin to the Sextarial system, without taking over the Eginetan talent of 2,592 C.I. itself.

He solved the difficulty by taking $\frac{1}{100}$ of the Eginetan talent as his mina—viz., 25·92 C.I., which, multiplied by 60, produced the Attic talent of 1555·2 C.I. : identical with the Roman Amphora, and $\frac{1}{30}$ of our Imperial cubic yard.

The new mina of 25·92 contained 6,480 O.G.T. (the Attic mina), and the drachma, 64·8 O.G.T., or 65·4 G.T. (the Attic drachma).

There were thus $138\frac{8}{9}$ Attic drachmas to a Euboic mina.

Commerce and the habits and inclinations of the people had not been considered sufficiently by Solon in making these changes ; and the Euboic sextarial measures continued in use by the people for several hundred years after Solon ; until at length drastic steps were taken to entirely efface the Euboic measures from the memory of the people. The exact date when this was effected is not known, but there is an Athenian inscription which gives some particulars, and which is attributed by Böckh to *circa* 160 B.C.

This inscription contained a Decree, and from it we learn that the Euboic system remained in use commercially after the changes made by Solon.

Hitherto the meaning of this Decree seems to have been imperfectly understood, and an explanation is here suggested clearing up the matter.

During the period which had elapsed from 550 B.C. to *circa* 160 B.C. the Attic drachma had remained steady at the standard weight, but the Euboic mina (36 C.I.) 9,000 O.G.T. had become reduced from $138\frac{8}{9}$ to 138 Attic drachmas—that is to say, to 8942·4 O.G.T.

The change that this Decree now sought to effect was to abolish the reduced mina of 8942·4 O.G.T. by adding 12 Attic drachmas, making it a new mina of 150 drachmas :

138 drachmas	8942·4	O.G.T.
12 drachmas	777·6	„
	9720·0	O.G.T.

thus making it equal to $1\frac{1}{2}$ Attic minas, or 38·88 C.I.

This new mina at 60 minas to the talent gave a new talent of 2332·8 C.I., the Sextarial Artaba, which was declared equal to 65 of the old commercial Euboic minas of 8942·4 O.G.T. giving a total of 2325 C.I.—within 8 C.I. of the new talent.

(This new talent of 2332·8 C.I. will be recognized as the Artaba introduced into Egypt after the new kingdom commenced, when the Sexagesimal system took the place of the Khar.)

Finally, six of the commercial minas of 8,942·4 O.G.T. (53,654·4 O.G.T.) were declared equal to five Eginetan minas of 10,800 O.G.T. (54,000 O.G.T.), the difference of 345·6 O.G.T. being due to the loss of $\frac{8}{9}$ Attic drachma in the mina.

The change, therefore, was from Euboic and Gudean to Sextarial or Eginetan measures, the new talent being the Assyrian Artaba (2332·8 C.I.), formed on the Assyrian Great U foot cubed.

The following Table gives the changes effected :

	Proportion.	C.I.	O.G.T.			O.G.T.
			$\frac{1}{60}$	$\frac{1}{80}$	$\frac{1}{100}$	Drachma.
Euboic (bushel) ...	25	2160·0	9,000	6,750	5,400	90·0
Eginetan (talent) ...	30	2592·0	10,800	8,100	6,480	108·0
Attic, 550 B.C. ...	18	1555·2	6,480	4,860	3,888	64·8
By Decree, 160 B.C.	27	2332·8	9,720 $\frac{1}{72}$ 8,100	7,290 The Log	5,832 —	— —

There are a series of weights in the British Museum, brought from Athens by W. Burgon, of which the three in best preservation weigh respectively 7,171, 9,980, and 12,872 G.T. These are supposed to be as early as 431 B.C. (but this is conjectural). If they are corrected by about 2 per cent. for loss of weight they are the Attic weights of Decree 160 B.C. mentioned above.

Burgon Weights.	G.T.	Correction 2 per Cent.	G.T.	O.G.T.	
No. 1 ...	7,171	+148	7,319	7,290	$\frac{1}{80}$ Artaba of 2332·8
No. 2 (overweight).	9,980	−163	9,817	9,720	$\frac{1}{60}$ C.I.
No. 3 ...	12,872	+216	13,088	12,960	Double Attic Mina.
Half of No. 3	6,436	+108	6,544	6,480	Attic Mina of Solon.

Subdivisions of the Attic Talent of 388,800 O.G.T. (1555·2 C.I.).

The Greeks followed the Babylonians in their subdivisions: 60 minas, 6,000 drachmas, and 36,000 obols to the talent.

The Greek obol is said to have been divided into 10 chalci, according to some, and into 8 chalci according to others. Sexagesimally, there should have been 10 chalci to an obol, giving 60 chalci to a drachma, and 360,000 chalci to a talent.

But when the number of drachmas to a mina was reduced to 96 in late Greek times, then there might naturally be a change in number of chalci to an obol.

Some say that the Greeks did not use grains, and that the chalchus was a unit; but it seems probable that the chalchus was both a unit and the grain. The obol was 10·8 O.G.T., and the chalchus (at 10 to an obol) would be 1·08 O.G.T. (or as 25 chalci to 27 grains Troy). Now, the ancient barley used by

Romans is as 24 to 27 grains Troy (see Table XXIII.). So that there would be 25 chalci to 24 ancient barley (see Table XXXI.), which is the usual proportion between Greek and Roman measures. This would give 360,000 Greek grains or chalci to a talent, and thus the minas (Burgon weights) of 7,290, 9,720, 6,480 O.G.T. (see last page) would be 7,200, 6,750, 6,000 Greek grains.

It has been stated by writers that before the time of Solon there were 72 drachmas to the mina, and that he reduced the weight to 100 to the mina. This admits of a simple explanation. He reduced the drachma (Euboic measure) from 90 O.G.T. to 64·8 O.G.T. (Attic), and this is in the proportion of 72 : 100. The following table gives the number of drachmas to the several talents :

	C.I.	Number of Drachmas in Each Talent.		
		Euboic.	Eginetan.	Attic.
Euboic talent	2160·0	6,000	5,000	8333·3
Eginetan talent	2592·0	7,200	6,000	10000·0
Attic talent	1555·2	4,320	3,600	6000·0

Reduction of the Mina from 100 to 96 Drachmas.

The Greeks spread their colonies over Asia Minor, Southern Italy, and Sicily, and in process of time the Attic mina of 6,480 O.G.T., with its 100 drachmas, had a very wide circulation.

When Rome made the change from 100 to 96 drachmas to the pound, a corresponding reduction was made in the weights of other countries, and the Greek mina became reduced, as below, the drachma remaining at its original value in each case :

	100 Drachmas. O.G.T.	96 Drachmas. O.G.T.	
Attic mina	6,480	6220·8	Called pound of Irak.
Tower old pound ...	5,400	5184·0	Roman pound.
Revised hon ...	6,750	6480·0	Attic mina.

The pound of Irak was in common use in Asia Minor in the time of the Seleucidae (Vazquez Queipo, I., p. 351), and in Greek grains it would number 5,760.

Stater.

The Stater was the chief coin (weight and money) in the Early Greek system, and when gold was coined the name "Stater" was applied to the principal coin of Greece, usually conforming to the Attic standard.

Therefore a Stater is a gold coin equal in weight to two Attic drachmas.

Greek Measures of Capacity.

The following are suggested changes in measures of capacity :

TABLE XIX.

Euboic.		Attic.		500 B.C. to *circa* 200 B.C.	After 200 B.C.	After 160 B.C.
	C.I. [25 18]			C.I. [4 6]	C.I. [2 1]	C.I.
Mina ...	36	$\frac{4}{5}$	Pound	25·92	38·88	19·44
		1	Xestes	32·4	48·6	24·3
		2	Choenix	64·8	97·2	48·6
		6	Chous	194·4	291·6	145·8
		8	Hemihecton	259·2	388·8	194·4
		16	Hecteus	518·4	777·6	388·8
Bushel ..	2,160	48	—	1555·2	2332·8	1166·4
		72	Metretes	2332·8	3499·2	1749·6
		80	Cubic foot	2592·0	3888·0	1944·0
		96	Medimnus	3110·4	4665·6	2332·8

The first column gives the original Euboic measures; in the time of Solon the modified Babylonian measures were introduced, and subsequently further changes took place.

Roman Measures.

Civilized races with weights and measures may have arrived in Italy in the following order. The dates are derived generally

from Clinton's "Fasti Hellenici," and are merely given for the purpose of locating the events in some general order :

B.C.

— Early inhabitants with the original Hon and Octaval measures in use (see p. 7).

1400. Pelasgi arrive with revised Hon or Octogintal measures and Tower pound.

1200. Umbrians arrive with 18-inch cylinder and Artaba of 2304 C.I.

1100. Etruscans.

753. Rome founded.

700. Greeks in Southern Italy with Euboic sextarial measures and mina of 36 C.I.

600. Phœnicians with Gudean talent of 1800 C.I. and pounds of 7,500 and 5,000 O.G.T.

400. In Etruria silver coins struck. Karsha (of 80 Rati or 135 O.G.T.), marked x, v and ıı. Thus the unit is 8 Rati, the base of the Euboic system. At a later date (350 to 258 B.C.) coins of the same weight are marked xx. x. v.

369. Silver coined in Rome.

200. Rome lowered the number of drachmas from 100 to 96 to the Roman pound, the drachma remaining at 54 O.G.T. (the old ducat or Varaha). Then all pounds throughout the Roman Empire followed suit, being reduced 4 per cent.

160. Roman measures changed by Silian Decree in the proportion of 4 : 3, making the Roman measures to correspond to those of Babylonia and Greece.

A.D.

300. Further change as 15 : 16.

The Early Roman Weight Pounds.

The only pounds the Romans could have possessed in early days are the two Hons of 6,912 and 6,750 O.G.T., and the Tower pound of 5,400 O.G.T. with the Euboic bushel measures. The Tower pound is $\frac{1}{100}$ of Euboic bushel, and $\frac{1}{120}$ of Eginetan talent (called also the Egyptian or Alexandrian talent). The Tauromanian inscription states that the Litra or Libra of Sicily was $\frac{1}{120}$ of the Egyptian talent, and the Roman pound was considered equal in weight with the Sicilian Litra. It appears

certain, then, that the Litra of Sicily and the Tower pound were identical.

Now, there are two distinct pounds deducible from Roman records and remains, differing in weight about 4 to 5 per cent. The one is certainly 5,184 O.G.T.—96 drachms of the 5,400 O.G.T. Tower pound of 100 drachmas. The other is estimated at from 4,980 to 5,080 O.G.T. There appear to be only three old pounds which will satisfy this requirement:

1. The Bosphoric pound of 5,000 O.G.T., found at sea-ports visited by the Phœnicians, ninety to the Phœnician talent. This is the pound from which Don Vasquez Quiepo considers the Roman coins to be weighted.

2. The pound of 5,062·5 O.G.T., is $\frac{3}{4}$ of the revised Hon of 6,750 O.G.T. It is proposed by Mr. E. W. Robertson, "Historical Essays," p. 1.

3. The Occidental or Byzantine pound of 4,860 O.G.T., 80 to the Amphora.

It is probable that these three pounds were all in use for various purposes. There were in later times various other pounds succeeding each other down to the fall of the Roman Empire. It is proposed to show what these pounds were.

The historian Priscian, "Weights and Measures," A.D. 500 (?), gives an account of the Roman pounds of his day. He was born in Cæsarea, and was employed at Constantinople, and was a citizen of the Roman Empire.

He states: "One hundred drachmas go to the weight called by the Greeks MNA, and by our forefathers mina. Take away four drachmas, and you have *our pound;* deduct one-fourth and you have the Attic mina."

"Our pound" at that time, at Constantinople, was probably the Roman 5,184 O.G.T., and by adding 4 drachmas (of 54 O.G.T.) to it we have the Tower pound, 5,400 O.G.T. Deduct one-fourth from the Tower pound, and we have the Attic pound, 4,050 O.G.T., of later times, half the log (8,100 O.G.T.):

5,400 (100 × 54) = Greek MNA, or old mina.
5,184 (96 × 54) = "Our pound," the Roman Empire pound.
4,050 (75 × 54) = Attic MINA, the half log.

Priscian further mentions:

	Remarks.
The Attic pound or mina of 80 drachmas. The Greek ,, ,, 96 ,,	80 × 54 = 4,320 O.G.T. 96 × 54 = 5,184 O.G.T.
Small Athenian talent of 60 minas.	(60 × 5,184 =) 311,040 O.G.T.
Great talent of 83⅓ pounds, equal to 100 Attic minas.	(1,728 C.I.) 432,000 O.G.T. 83⅓ pounds (of 5,184) = 80 × 5,400.
According to computation of Livy, 100 Attic minas, of which each is 75 drachmas, equal a Great Talent.	This is not understood, as the Attic talent has 100 minas of 80 Drachmas.
For minas have 60 drachmas, according to Dardanus. The Italian mina has 96, a mina of 12 ounces or 72 denarii.	The denarius is the Aureus denarius of Constantine, 72 to a pound of 5,184 O.G.T.
By this computation 83⅓ Roman pounds (the Great Talent) make 100 Attic.	

We have now to place these minas in order according to dates:

Rome (before 200 B.C.).	Byzantium or Constantinople.
Old Hon 6,912 O.G.T. Tower pound ... 5,400 ,,	— —
After 200 B.C.	
Old Hon, 128 drachmas 6,912 O.G.T. Roman pound, 96 drachmas 5,184 ,, 5,000 ,,	Tower pound ... 5,400 O.G.T. Attic pound ($\frac{1}{100}$ Greek talent) ... 4,320 ,,
Uncertain (later).	
So-called Occidental pound, 4,860 O.G.T. Roman Amphora pound, 3,888 ,,	Attic MNA (½ Log) 4,050 O.G.T. Mina according to Dardanus, 3,240, O.G.T. ½ Attic mina. Roman Amphora pound, 3,888 O.G.T. Small Athenian mina, 3110·4 ,, Half pound of Irak of 6220·8 ,,

Note.—In Robertson's "Historical Essays," a drachma of 50·625 O.G.T., instead of 54 O.G.T. is used, making all results less by $\frac{1}{16}$.

Measures of Capacity.

The Silian Plebicitum Decree preserved by Festus, *circa* 160 B.C., gives the proportions of the later measures of capacity, one to another, as is shown in annexed Table XX.

The amphora (cubic foot) contained 80 pounds of wine, giving the Occidental pound of 4,860 O.G.T.

There is still a congius of Vespasian which gives a limit for the pound of 5,116 O.G.T.

TABLE XX.

200 B.C.				160 B.C.					
	Euboic.	[100	96]		C.I.	O.G T. [4	3]	C.I.	O.G.T.
21·60	5,400	Tower pound	Roman pound	—	20·736	5,184	Amphora pound	15·55	3,858
27·0	6,750	Hon	Attic mina	—	25·92	6,480	Occidental pound ...	19·44	4,860
			Sextarius	1	32·4	8,100	Sextarius	24·3	6,075
			Congius ...	6	194·4	48,600	Congius...	145·8	36,450
			Urna ...	24	777·6	194,400	Urna ...	583·2	145,800
			Amphora	48	1555·2	388,800	Amphora	1166·4	291,600
2160·0	540,000	Bushel	— 109 80	64	2073·6	518,400	—	1555·2	388,800
			Metretes...	72	2332·8	583,200	Metretes	1749·6	—
			Medimuus	96	3110·4	777,600	Medimnus	2332·8	583,200
			Culeus ...	960	31104·0	—	Culeus ...	23328·0	—

The Roman Weight Pound (of the Empire).

The weight of the Late Roman pound is firmly established as 5,184 O.G.T., or 5,235 G.T. It still retained its weight of 5,235 G.T. at Rome, and 5,240 G.T. at Leghorn in 1829 (Kelly's "Cambist"). The weight of the grain was then Troy wheat ($\frac{3}{4}$ Troy barley grain), thus giving 6,912 Troy wheat to the pound. The pound was divided into 12 ounces, possibly derived from the Western Babylonian through the Etruscans.

The Roman 12 ounce pound belongs to the Sextarial system, but the 16 ounce pound is the old Hon: the earliest pound is 24 shekels, or 12 revised ounces of 432 O.G.T. (or 512 Ancient wheat, or half rati); so that the Romans, or their predecessors, evidently commenced with binary measures.

Regarding the ounce, the Romans followed the Greeks in

dividing it into 8 drachms, and the drachm into 6 obols; but they introduced two new weights—the Scripulum and Siliqua. The Roman divisions of the pound are familiar to us through our Apothecaries' Weight, but our Troy weight exceeds that of the Romans as 10 : 9.

TABLE XXI.

Roman Pound (Empire).

See Arbuthnot's Tables.	Troy Wheat.	O.G.T.
Troy wheat	1	$\frac{3}{4}$
Siliqua, Keration ...	4	3
Obol	12	9
Scripulum	24	18.
Drachma	72	54 Ducat
Uncia	576	432
Libra	6,912	5,184
Hundredweight ...	69,120	518,400

TABLE XXII.

Egypt (Roman Influence).

See Queipo's Tables.	Obol.	Kerat.	O.G.T.
Siliqua, Keration ...	—	1	3
Obol	1	3·6	10·8
Drachma	5	18	54
Sextula	$6\frac{2}{3}$	24	72
Stater	20	72	216
Uncia	40	144	432
Libra	480	1,728	5,184
Hundredweight ...	—	—	518,400

The following system of weights ascending by multiples of ten, and culminating in the Alexandrian talent, or Old Baby-

lonian talent (or cubic foot), was used in Egypt during Roman influence (derived from Greece or Macedonia). No changes in weights appear to have been made until the fifth or sixth century A.D.

	Obol.	O.G.T.
Attic Obol	1	10·8
Drachma	6	64·8
Mina (Attic)	600	6480·0
Talent	60,000	648000·0

	Obol.	O G.T.
Attic Obol	1	10·8
Drachma	5	54·0 Ducat
Mina	500	5400·0 Tower pound
Talent	60,000	648000·0

Changes in Money Weights.

The money weights constantly fluctuated during Roman history, and fell into confusion under the Emperors until the time of Diocletian, when a reform was commenced and placed on a firm basis by Constantine, *circa* A.D. 330.

	Follis.	Copper. O.G.T.	Silver. O.G.T.	Gold. O.G.T.
Nummus Follis (copper)	1	432	—	—
Keration, Siliqua (silver)	12	5,184	43·2	—
Milliarensis	24	10,368	86·4	—
Solidus aureus	288	—	1036·8	72

There were 72 gold solidi to a pound, so that the Roman pound of 5,184 O.G.T. must have been in use in Constantinople until a late period.

"All the standards of medieval Europe (with the exception of the Irish) were based on the gold *Solidus* of Constantine the Great. The *Solidus* itself (weighing 72 grains Troy, or $\frac{1}{72}$ Roman

pound) was divided into 24 *Siliquæ*. The *Siliqua*, or, as the Greeks called it, *Keration*, was the seed of the carob ("Origin of Currency," Ridgway, p. 181).

The Early Roman Pound and the Denarius.

The original pound of Italy and the Romans was the old Hon of 6,912 O.G.T.

The massive copper ingot in the Pembroke Collection, a Roman quadrussis (4 pounds) of early date weighing 27,662 G.T., at the rate of 6915·5 G.T. to the pound, is close on the weight of the old Hon of 6,912 O.G.T. This *Aeris Libra*, or pound weight of copper, belongs to a remote epoch in Italy, probably the fourth century B.C. (See Humphrey's "Coin Collector's Manual," p. 251).

Had the Romans originated a silver coinage entirely for their own use, they would probably have adhered to the weight of the old Hon and its divisions into 32 shekels; but as money weights were, in a great measure, for the purposes of exchanges with neighbouring tribes, they were bound to keep in touch with the highly civilised Greek and Asiatic tribes which had arrived in Italy in the early days of Rome, and which made use of the Moneyer's pound of 5,400 O.G.T. for their silver coinage.

The Romans would thus be likely to adopt as the denarius the Karsha and its division (135, 67·5, and 33·75 O.G.T.) from the Etruscans (see "Origin of Currency," Ridgway, p. 363); or else the Euboic sextarial drachma of 90, 45, and 22·5 O.G.T. from Sicily. Humphreys ("Ancient Coins," 1850, p. 191) says: "This silver coin [the denarius], originating in the Republic at the weight of 90 grains, being in the reign of Augustus 60, and in mid-empire 58, was eventually reduced to 10: shortly before that it became the parent of the Anglo-Saxon silver penny."

The Roman aureus, double of the denarius, probably commenced at a weight of 135 O.G.T.; in the time of C. Cæsar Cos III. (about 63 B.C.), it weighed 124 G.T. (see Greaves's "Denarius," p. 104).

I suggest, then, that originally the silver denarius weighed 90 O.G.T., after the Euboic sextarial drachma, but that subsequently it was reduced to 67·5 O.G.T., or half a Karsha, following the silver coinage of the Etruscans, about 269 B.C.

TABLE XXIII.

Egyptian Ptolemaic, before and after Roman Dominion.

Euboic.			Babylonian.				Babylonian.	Persian.	Olympic.	Late Attic.	
C.I.				C.I.		Name.	C.I.	C.I.	C.I.	C.I.	
27	1	Hon	1	25·92	1	Cadua ...	32·4	60	25	24·3	—
					4	Makuk	129·6	240	—	97·2	—
			10	259·2	8	—	—	—	—	—	—
					16	Woeba ...	518·4	960	400	388·8	—
					24	Woeba ...	777·6	—	—	—	—
					48	—	1555·2	2,880	—	—	—
					72	—	2332·8	—	1,800	1749·6	Artaba.
2,160	80		—	—	80	Artaba	2592·0	—	—	—	—
			100	2592·0	96	Artaba	3110·4	5,760	2,400	2332·8	Medimnus.

Roman Linear Measure.

This is a compromise between the original Babylonian system and the Sexagesimal Babylonian measure. The great circle is divided into 360 degrees of 6,000,000 digits of 0·7275 inch ; but there are 80,000 digits to a mile (as in the Euboic system) of 5,000 feet each—the foot being 16 digits. Thus the old Roman foot of 11·64 inches is preserved. The mile is 138 yards short of the old mile. There are 27,000 miles to a great circle.

The Roman linear measure continued in use in Southern Europe until the sixteenth century, but the length of the foot varied. The Gallic league does not seem to be an ancient measure ; it does not fit into Euboic measure.

TABLE XXIV.

See Table IV.	Roman Measure.			Imperial Measure.	
	Digit.	Foot.	Mile.	Inches.	Yards.
Digit	1	—	—	0·7275	—
Foot	16	1	—	11·64	—
Pace	80	5	—	58·201	—
Actus	1,920	120	—	6985·4	—
Mille passus	80,000	5,000	1·0	5820·1	1,616
Gallic league	120,000	7,500	1·5	87301·0	2,425
Degree	6,000,000	375,000	75·0	4365070·0	—
360 Degrees	2,160,000,000	135,000,000	27000·0	1571428000·0	—

Egypt.

Heron of Alexandria (*circa* A.D. 600) gives one ancient and two modern systems of linear measure; both he and Didymus (of the same period) give the same proportions between the digit, palm, Italian foot, and cubit. The unit can thus be arrived at within 1 per cent. of the truth, as the length of the Italian foot and Egyptian cubit are known nearly, and by making the unit too great on one side the Italian foot is too small, and by making the unit too great on the other side the cubit becomes too great.

It is evidently a system brought in about the time of the later Ptolemies to accommodate Gudean, Egyptian, Grecian, and Roman measures.

I take the mile ($\frac{1}{25000}$ earth's circumference with $\frac{22}{7}$) as the unit, which gives exactly the Roman and Gudean feet. The mixture of systems is very interesting. Thirty-two divisions of the Gudean scale make the cubit; the true measure is $31\frac{1}{2}$, so that the 20·61 inch cubit is prolonged by 0·327 inch. The 288,000 digits to the parasang is Persian, adopted by Moslems in later years. The digit itself is $\frac{1}{3}$ of the Gudean digit, and $\frac{10}{9}$ of the $\frac{22}{7}$ digit. The system generally resembles that adopted by the Moslems in later times (Table IV.).

TABLE XXV.

	Digit.	Italian Foot.	Cubit.	Imperial Inches.	$\frac{22}{7}$ Digit.	Gudean Digit.	
Gudean digit ...	—	—	—	3] 0·654	—	1	60 to 39·25 inches.
Digit $\frac{22}{7}$	—	—	—	9] 0·785	1	—	—
Digit	1	—	—	4] 10] 0·873	—	—	—
Palm	4	—	—	3·492	—	—	—
Spitham (Span)	12	—	—	10·476	—	16	Exactly the late Gudean foot.
Italian foot ...	$13\frac{1}{3}$	1	—	11·640	—	—	Exactly Roman foot.
Pigon	20	—	—	17·460	—	—	—
Cubit	24	—	1	20·952	—	32	—
Step	40	3	—	34·920	—	—	—
Xylon	72	—	—	62·857	80	96	—
Orguia (fathom)	96	—	—	83·809	—	—	—
Calamus	160	12	—	139·682	—	—	—
Stade	9,600	720	400	8380·949	—	—	—
Mile	72,000	5,400	3,000	62857·120	80,000	96,000	1,746 yards.
Schænus } Parasang } ...	288,000	21,600	12,000	251428·480	320,000	384,000	—

Moslems (from *circa* A.D. 650).

There have been three great breaks with the past:

(*a*) The Gudean, or old metre, system (already dealt with).
(*b*) The Black Cubit system.
(*c*) The French Metre system.

(N.B.—The loss of 1 per cent. in weight of the Troy grain appears also to affect many Moslem weights).

The Black Cubit System.—The Moslems are said to have originated no new measures, but they certainly brought the Black cubit (Persian 21·36 inches) into prominence, and gave it a new bias.

They raised many old weights in the proportion of 9 : 10, and, whilst using the new weights, still continued the old ones in various countries.

		[9 10] Moslem Innovation.	
The Babylonian cubic foot	2,592 C.I.	The Black cubit (21·3 inch) cubed	2,880 C.I.
The Babylonian cubic foot	648,000 O.G.T.	The Black cubit (21·3 inch) cubed	720,000 O.G.T.
Attic pound	6,480 ,,	The Moslem Rotl	7,200 ,,
Attic drachma	64·8 ,,	The Miscal	72 ,,
The old hon of 16 ounces	6,912 ,,	The Scotch Troyes (16 oz. Troy, or Dutch Weight)	7,680 ,,
Roman pound of 12 ,,	5,184 ,,	The Troy pound	5,760 ,,
The old ounce	432 ,,	The Troy ounce	480 ,,
The siliqua	43·2 ,,	The Moslem Dirhem (Këil)	48 ,,
The revised hon	6,750 ,,	The Gudean pound ...	7,500 ,,

The following weights were dubbed Moslem:

The Attic Drachma or Dinar	...	64·8 O.G.T.
The Silver Dirhem		32·4 ,,

The following suffered no change:

The Ptolemaic pound (Tower pound)		5400·0 O.G.T.
Drachma		54·0 ,,

The Dirhem Këil of 48 O.G.T. was the Silver dram of Turks, Persians, and Moguls in A.D. 1647 (Greaves). At the same time the drachma, 54 O.G.T. was the Turkish Sultani,

or Egyptian Shereeffa (gold coin), agreeing in weight with the Barbary and Venetian sequin, and Nuremberg ducat.

The Moslems reckoned 100 pounds to a Kantar, or hundredweight, as did the Romans.

The Moslem standard weight of later times is the Dram (Dirhem Këil) of 48 O.G.T., the 120th of pound Troy (some writers also give the 100th of pound Troy, 57·6 O.G.T. as the Dirhem).

The Turkish and Egyptian Oke is 400 drams, equal to 19,200 O.G.T., originally, perhaps, 19,440 O.G.T.

In Constantinople,	in 1647,	Greaves	found the Oke	to be	19,128 G.T.
In ,,	1828,	Kelly	,, ,,		19,920 ,,
In Alexandria	,,	,,	,, ,,		18,700 ,,
In Hungary	,,	,,	,, the Occa	to be	18,451 ,,
In Cyprus	,,	,,	,, ,,		19,570 ,,
In Patras	,,	,,	,, ,,		18,204 ,,
In Ragusa (Dalmatia)	,,	,,	,, ,,		20,671 ,,
In Smyrna	,,	,,	,, ,,		19,830 ,,
In Zante	,,	,,	,, ,,		18,900 ,,

The weights of this oke or occa are given in detail because it is an exceptional weight, unconnected with any of the pounds in general use in medieval times in Europe and Asia. It must have been reckoned in Troy grains, as there is only one multiple of 3. The Prophet's oke or rotl is 480 drachmas of 43·2 O.G.T. (4 Roman pounds or $400 \times 51{\cdot}84$ G.T.). There seems reason to suppose that the original dram was the late Attic drachma of 48·6 O.G.T., reduced subsequently (as 81 : 80) to 48 O.G.T., in which case the original oke would have been 19,440 O.G.T.—equal to 4 Occidental pounds of 4,860 O.G.T. This will account for its locality about Constantinople.

Makadassi (*circa* A.D. 985) gives the following Syrian measures :

Sa.	Name.	Contents Uncertain.	Makadassi Barley corn.	Name.	G.T.
1	Sa	$\frac{2}{3}$ gallons	1	Barley corn	0·72
$1\frac{1}{2}$	Kailejah	1 ,,	$3\frac{1}{2}$	Kirat	2·52
$4\frac{1}{2}$	Makuk	3 ,,	10	Dank	7·2
6	Cabb	4 ,,	60	Dirhem	43·2
9	Waibah	6 ,,	84	Dinar	60·48
24	Muidi	2 bushels			
36	Khafiz	3 ,,			

The following are the principal weights:

Name.		O.G.T.	C.I.	
Miscal Kantar	See Scale of Ananias of Shiraz	720,000	2880·0	The Black cubit cubed.
Phœnician ...	100×7,500, Gudean pound	750,000	3000·0	$\frac{1}{26}$ of Gudean cubit cubed.
Cairo	100×6,912, Cairo Rotl	691,200	2764·8	—
Maimonides...	150×6,912, ,, ,,	1,036,080	4147·2	—
Babylonian ...	100×8,100, the Log	810,000	3240·0	—
Alexandrian	100×6,480, Attic Mina	648,000	2592·0	Alexandrian talent.
Irak	100×6220·8, Irak pound	622,080	2488·3	—
Roman ...	100×5,184, Roman pound	518,400	2073·6	Roman Hundredweight.
Uncertain ...	120×6,912 / 160×5,184	829,440	—	Florence, Constantinople.

Capacities: See Queipo.

		O.G.T.	C.I.	
Artaba, Dry	—	720,000	3,840	4] for corn.
,, Wet	—	720,000	2,880	3] for liquids. Black cubit.
,,	Cairo	—	3 × 3,840	—
,,	Rosetta	—	4 × 3,840	—
,,	Damietta	—	8 × 3,840	—
,,	Syout	—	$\frac{11}{4}$ × 3,840	—

The measure, 3,840 C.I. for the Artaba (Fanega), exists in Spain at the present day. The Moslem writers say that they adhered to the Ancient pounds and other weight systems, and that they computed 128 Rotl (pounds) to the Artaba.

128 Rotl of 30 C.I. (Gudean) = 3840 C.I.

Moslem Weights.

The table (XXVI.) of Ananias of Shiraz (seventh century) is a most important link between the Ancient and Moslem weights. Here we find linked together the half-shekel, pound and ounce of Imperial Rome, smaller Roman weights, Babylonian talent, and Moslem Black double cubit cubed.

The unit is the Moslem Habbas, the Troy wheat grain, ·75 O.G.T.

The Black double cubit cubed (2,880 C.I., Table V.) is the Persian Artaba, and is 100 Moslem Rotl of 7,200 O.G.T.

TABLE XXVI.

Habbas.	Quiepo III.	O.G.T.	
1	Grain	$\frac{3}{4}$	—
2	Assarion or Lepton	$1\frac{1}{2}$	—
3	Pashet	$2\frac{1}{4}$	—
4	Kerat	3	Siliqua.
16	Sing	12	—
24	Grammar	18	Obol Eginetan Scruple.
32	Termes	24	Tremissis.
48	Simes	36	Djunk Semissis.
72	Drachma	54	Ducat.
96	Dahekan	72	Aureus Solidus of Constantine. Miscal Exagion.
144	Shekel	108	Half-shekel. Eginetan drachma.
576	Uncia	432	Roman ounce.
6,912	Litra	5,184	Roman pound.
100 Litra	Kendinar	518,400	Roman Hundredweight.
125 ,,	Taland	648,000	80 Logs. Babylonian talent.
138 ,,	Chankar or Kankar	715,392	Short by $\frac{8}{9}$ Roman pounds.
$138\frac{8}{9}$,,	Moslem Black cubit cubed	720,000	—

TABLE XXVII.

The Moslem Pounds and their Divisions.

	Name.	Old Hon.	Tower Pound (Ptolemaic).		Roman.	Attic Irak.	Persian.	Troy.	Prophet's Rotl.	
		O.G.T.	O.G.T.	Old Barley.	O.G.T.	O.G.T.	O.G.T.	O.G.T.	Name.	O.G.T.
1	Obol ...	14·4	11·25	10	10·8	12·96	15	12	Drachma	43·2
5	Drachma	72·0	56·25	50	54·0	—	75	60	Nivat ...	216·0
20	Shekel .	288·0	225·0	200	216·0	259·2	300	240	Naseh ...	864·0
40	Ounce ...	576·0	450·0	400	432·0	518·4	600	480	Okia ...	1728·0
120	—	—	—	—	—	—	—	—	—	5184·0
480	Pound ...	6912·0	5400·0	4,800	5184·0	6220·8	7,200	5,760	Oke ...	20736·0

It is apparent that the division of the Moneyer's pound into 240 denars in the Early Middle Ages came from the Ptolemaic system, taken over by the Moslems.

(480 Obols, or Sesterces of 10 Ancient barley, or 240 Denars.)

TABLE XXVIII.

MEASURES DERIVED FROM THE PERSIANS, CONTAINING THE OLD SEXAGESIMAL MEASURES.

	See Queipo's Tables.	Liquid (Early). C.I.	Liquid (Late). C.I.	Dry. C.I.
1	Mudd	30	32	40
2	Kist	60	—	—
4	Sa	120	128	160
6	Makuk	180	—	240
12	Firk	360	384	480
16	Woeba	480	—	640
24	Woeba	720	768	960
48	Khafiz	1,440	1,536	1,920
72	—	2,160	2,304	2,880
96	Artaba	2,880	3,072	3,840
384	Den	11,520	12,288	15,360

When the Gudean measures were first established the ratio of 8 : 10 for liquid and corn appears to have been given up, and 3 : 4 substituted.

30 C.I. of water = to 40 C.I. of corn, as must be necessary in Sextarial and Sexagesimal measures, if 60 pounds represent liquid measure and 80 pounds dry measure. But in process of time there appears to have been a revolt against Sexagesimal measures, and 32 C.I. was substituted for 30 C.I., giving 2,304 C.I. to the Artaba, and restoring the proportion of 8 : 10 for liquids and corn. This would probably have taken place when the 18-inch cylinder was brought in and the Hon raised from 27 C.I. to 28·8 C.I.

These changes from Euboic to Eginetan measures and back again may mark the irruption and retirement of Northern races upon and from Babylonia and Egypt.

The binary foundation of above table may be noted. If $1\frac{1}{3}$ is substituted for 1, the numbers 12, 24, 48, and 96 become 16, 32, 64, and 128 ; and the 40 Dry C.I. become 30 Dry C.I. 30 C.I. is one half of $\frac{1}{1000}$ Gudean double cubit cubed. Thus it is evident that the Gudean measures were originally binary.

CHAPTER IV

EARLY WEIGHTS AND MEASURES OF NORTHERN EUROPE AND BRITAIN, AND THE MEASURES FROM PREHISTORIC REMAINS.

A DIFFICULTY arises in the consideration of weights and measures of Northern Europe, because those coming from Southern Europe are a little over weight, whilst those coming from the East and from the Moslems are generally about 1 per cent. under weight: our Troy grain being 1 per cent too light.

For example, the following weights from the South are over weight:

The old Hon, 6,912 O.G.T., runs from 7,000 to 7,100 G.T.
The Roman pound, 5,184 O.G.T., runs from 5,232 to 5,256. G.T.

The result is that our *modern* Avoirdupois weight is nearly correct.

The following are about 1 per cent. under weight, though the numbers of grains are correct: Tower pound, 5,400; Troy pound, 5,760 G.T.; Commercial pound (poid de Marc), 6,750 G.T.; Occidental pound (raised by $\frac{1}{6}$), 5,670 G.T.

The bushel from the old Hon of 6,912 O.G.T. should be 2211·84 C.I., and actually is, in our Imperial measure, 2218·191 C.I.—difference only 7 C.I. in 2,211.

On the other hand, the cubic foot which is of correct dimensions contains 1 per cent. too many grains Troy. It ought to contain 64 round Hon of 27 C.I (6,750 O.G.T.), or 75 pounds Troy.

It contains 1,000 ounces Avoirdupois.

In consequence of this difference of value in the grains Troy, from the East and from the South, and the uncertainty as to the epoch in medieval times when the depreciation took place,

the terms *Old Grains Troy* and *Grains Troy* are sometimes interchangeable.

THE VARIOUS POUNDS AND MARCS IN EUROPE, 1821 (KELLY'S "CAMBIST").

I have tabulated the 16-ounce, 12-ounce pounds and marcs of 8 ounces found all over Europe, given in Kelly's "Cambist," and find that they fall, with a few abnormal exceptions, within well-defined areas. The marc of 8 ounces was used all over Europe for weighing gold and silver, and in Northern Europe its double was used for merchandise, whilst in Southern Europe the 12-ounce pound was used.

In the old Roman Empire and East Europe, the Roman pound and old Hon will be found to West, and the Occidental and Attic pounds to East. In Northern Europe the Moneyer's pound will be found, and overlying it in some parts the more recently arisen Troy pound.

(1) Average of 7: 5,215 G.T., Roman pound	5,184 O.G.T. 6,912 ,,	Rome, Florence, Southern Italy, South of France, Spain, and Portugal.
(2) Average of 8: 4,782 G.T., Occidental pound	4,860 O.G.T. 6,480 ,,	Poland, Western Austria, Western Russia, Norway and Sweden.
Poid de marc	5,670 G.T.	France.
(3) Average of 11: 5,467 G.T., Moneyer's pound	5,400 G.T. 7,200 ,,	Germany, Denmark, East Switzerland, England, N.E. Switzerland, Venice.
(4) Average of 7: 5,692 G.T., Troy pound	5,760 G.T. 7,680 ,,	England, Holland, West Switzerland, West Italy as far as Turin, Turkey.

The old Hon of 6,912 O.G.T. is common to all countries as an underlying weight. The revised Hon of 6,750 G.T., our old commercial weight, is, so far as I can find, only found in England, where the cubic foot is accurately preserved.

This 6,750 G.T. is 15 ounces (450 G.T.) of the Moneyer's commercial pound of 16 ounces, 7,200; and 7,200 G.T. is 15 ounces (480 G.T.) of the Troy commercial pound of 16 ounces, 7680 G.T.

This may account for the statement of Dr. W. Clark ("Connexion of Coins") that in the earliest times the pound brought in by the Saxons was a 15-ounce pound.

The Troy pound (5,760 G.T.) seems to be clearly a Moslem weight, and to have derived its name from the French Troyes

weight, or poid de marc, of 5,670 G.T., which it so closely resembles in weight—only 90 G.T. difference.

The Principal Marcs of Europe, with their Derivatives.

The weights in Troy grains are taken from Kelly's "Cambist" and Robertson's "Historical Essays":

	G.T.
Northern Europe. Moneyer's Pound	5,400
Tower marc	3,600
Cologne marc (all Germany)	3,608
Augsburg ,, ...	3,643
Denmark ,, ...	3,633
Milan ,, ...	3,627
Venice ,, ...	3,681
Zurich ,, ...	3,616

		G.T.
Eastern Europe. Attic Pound		6,480
Vienna marc	Kelly	4,333
	Robertson	4,320
Swedish Mint ore		405

Northern France.	*Poid de Marc.*	*Attic Pound, plus one-sixth.*	G.T.
Marc de Troyes	3,240 + 54	= 3,780 ...	3777·6
——	4,860 + 81	= 5,670 ...	5666·6
Poid de marc	6,480 + 105	= 7,560 ...	7555·5

Southern France, Spain, and Italy. The Old Hon and Roman Pound.

		8 oz. Marc.	12 oz. Roman Pound.	Raised to 16 oz. Old Hon.
Tournois marc	Robertson	3,456	5,184	6,912
Roman pound	Kelly	—	5,234	6 978
Rochelle marc	,,	2,556	—	7,112
Limoges ,, ...	Robertson	3,506	—	7,000
French Esterling pound	,,	—	5,333	7,111
Castile (Spain)		3,556	—	7,100
Portugal		3,541	—	7,082
Madeira		3,538	—	7,076
Imperial pound		—	—	7,000
Old Hon in grains Troy		—	—	6,981
Gibraltar pound. Greaves, 1647		—	—	7,090
Spanish ,, Villal pandus		—	—	7,035
Roman ,, Greaves		—	5,286	7,048
$\frac{1}{125}$ Great Alexandrian Talent, 655,550 G.T. ...		—	—	6,992

The pound weight of 7,000 grains Troy, with its multiple of 56, is said ("Warden of the Standards," 1872-3, p. 27) to have been in use in England since the reign of Edward III., but there are no records giving the number or weight of grains into which it was divided. Greaves (1647), Hooper (1721), Arbuthnot (1754) state that it was within a grain of 7,000 G.T.; and the "Warden of the Standards" (1872-3), p. 19, states: "It may fairly be assumed that the true weight of the Exchequer standard avoirdupois pound of 7,000 Troy grains, like that of the Troy pound, has not varied in weight since the first introduction of avoirdupois into this country." Yet the Report of the Commission on Weights and Measures, 1825, speaks with an uncertain sound: "We had reason to believe that this pound cannot differ by more than one, two, or three grains from 7,000 grains Troy. It, therefore, occurred to us that we should be offering no violence to the system of weights if we declared that 7,000 grains Troy should hereafter be considered as the pound avoirdupois."

A possible solution is that the Troy grain from the South of Europe was slightly over weight, say, 20 grains in 7,000, so that the old Hon of 6,912 O.G.T. would weigh in British grains Troy $6{,}912 + 69{\cdot}12 + 20 = 7001{\cdot}12$ G.T.; on the other hand, it may have been a Moslem form of the old Hon of 7,000 G.T., as 6,750 G.T. $\times \frac{28}{27} = 7{,}000$; and the Moslems in India, as it will be seen, appear to have substituted 28 for 27 in their computations of weights. Hooper (1721) states that our pound avoirdupois may be reckoned a Roman pound of 16 of their ounces, called the *Mina Attica,* and that the Spanish pound is 7,000 Troy grains. Arbuthnot (1754) states: "The most ancient *Mina Attica* was exactly our Avoirdupois pound": "The Cairo rotl differs so little from the Spanish and our avoirdupois pound, which are of 16 ounces, and from the Roman *Mina Medicorum* which reckon as money, that it may well be esteemed as the standard from which the European was designed to be taken." The Cairo rotl at that time, and for the last 300 years, has not varied from 6,886 grains Troy. (See Pound Avoirdupois, p. 91 and Chapter VI.)

THE VARIOUS POUNDS IN USE IN EUROPE TO FOURTEENTH CENTURY, A.D., PLACED IN GROUPS: IN GRAINS TROY.

Name.	1	2	3		
	16-oz. Commerce.	12-oz. Pound.	8-oz. Marc.	1 oz.	
Old Hon ...	6,912	5,184	3,456	—	(1) Old Hon; (2) Roman pound; (3) Marc of Arragon.
Revised Hon ...	6,750	—	—	450	(1) 15 ounces.
—	7,200	5,400	3,600	450	(1) Commerce; (2) Moneyer's pound; (3) Cologne marc.
—	—	6,480	4,320	540	(2) Attic pound; (3) Marc of Vienna and North Europe.
Occidental pound	6,480	4,860	3,240	405	(1) Attic pound; (2) Occidental pound; (3) Marc of Merovingians.
One-sixth added Merovingian heavy pound ...	7,560	5,670	—	—	(1) Paris poid de marc; (2) Heavy poid de Troyes.
Troy pound ...	7,680	5,760	—	480	(1) Scottish Troyes pound; (2) Troy pound.

EARLY WEIGHTS.

With the Long Barrow men probably came the heavy Hon of 6,912 O.G.T. with its binary multiples and divisions, and the cubit of a man. Evidence of the existence of this Hon occurs all over Europe and the British Isles.

With the Round Barrow men probably came the revised Hon of 6,750 O.G.T. (the old British commercial pound).

With these two hons came the heavy and light bushels, which have competed with each other in Britain for several hundred years.

	O.G.T.	C.I. Hon.	C.I. Pint.	C.I. Bushel.	C.I.
Old Hon	6,912	27·648	34·56	2211·84	2218·0 Time of Queen Anne. 2219·0 Imperial measure.
Revised Hon ...	6,750	27·00	33·75	2160·00	2178·0 Winchester bushel. 2124·0 Henry VII. ,, 2128·0 Elizabeth ,, 2150·0 16th century bushel.

The Roman weights and measures came into Britain and went out again, leaving very little trace, because they were binary at base, and compared so readily with British binary measures. For example, the Roman pound of 5,184 O.G.T. is $\frac{3}{4}$ of the heavy Hon of 6,912 O.G.T.

The Early Grain Weight of Britain and Europe.

Up to about the time of the Roman occupation of Britain the grain weight in use was probably the ancient wheat grain, 2 to a rati, or 32 to 27 grains Troy, also used in Rome at that time. Thus :

The Hon of	6,912	O.G.T.	was divided into	8,192	ancient wheat	or half	rati.
,,	6,750	,,	,,	8,000	,,	,,	,,
,,	5,184	,,	,,	6,144	,,	,,	,,

The Troy grains (barley and wheat) may have also come into Britain at an early period, with Phœnician traders, though the Troy pound evidently was quite a late arrival.

Weights and Measures of the Period 300 B.C. to A.D. 300.

The following were brought into Britain by races from the East : The 12-inch foot, the cubic foot, the cubits 18 and 19.8 inches (the foot and link), the cylinder bushel of 2,304 C.I. ($\frac{1}{30}$ 69,120 C.I.), the 18-inch cylinder (Beer measure), the pound of 7,200 O.G.T., the Troy pounds of 5,760 and 7,680 O.G.T.

Apparently at a late date in this period the builders of the rude stone monuments arrived with the foot of 12 inches and 13·2 inches.

The British link measures appear to accord with the Belgic foot of the Tungri, called the Drusian foot, known about 30 B.C. in Roman history.

The Gothic or Northern Races.

The Gothic races are credited with having exclusively used the binary system in their reckonings, and therefore their original pound must have been either the original Hon of 4,096 rati (6,912 O.G.T.), or the still earlier Ganda half pound of 2,048 rati.

Underlying the remains of the old pounds just enumerated

as being found in Europe (5,760, 5,400, 5,184, and 4,860 O.G.T.), are still many indications that the old Hon (or half Hon) was in use in early times amongst the Gothic races.

Kelly's "Cambist" (1821) gives the following records of marcs and their sub-divisions, which appear to have been originally Gothic :

In Arragon, Spain, the marc of 8 ounces weighs 3,550 G.T., or 3,515 O.G.T., and this I take to be 3,456 O.G.T. (2,048 rati) rather than the marc of 5,400 O.G.T., which is 3,600 O.G.T. (2133·3 rati). This marc is divided into 4,096 grains or half rati. The following also seem to follow suit : Breslau 3,158 G.T., Reval 3,449 G.T., Ratisbon 3,326 G.T., Lisbon 3,541 G.T.

Arragon.			Breslau, Reval, Ratisbon, etc.			
O.G.T.	Ancient Wheat.		O.G.T.	Ancient Wheat.	Hellars.	
—	1	Arragonese grain ($\frac{1}{2}$ Rati).	—	8	1	Hellar.
			13½	16	2	Dinar.
27	32	Ariense.	54	64	8	Quintel, Quintin.
108	128	Quartello.	216	256	32	Loth.
432	512	Ounce.	432	512	64	Ounce.
3,456	4,096	Marc (2,048 Rati).	3,456	4,096	512	Marc.

I have to suggest that the Gothic races used the old Ganda pound of 2,048 rati (3,456 O.G.T.) until the fourth or fifth century A.D., when they took over the marc of the Moneyer's pound—that is to say, 3,600 G.T. instead of 3,456 O.G.T.

The Report of the Warden of the Standards (1872-73, p. 30) states : "The old Saxon pound of 12 ounces, weighing 5,400 G.T., like the old marc of Cologne, consisting of 8 similar ounces, which was the unit of money in Germany, is evidently borrowed from the ancient Ptolemaic monetary mina of Alexandria of nearly similar weight, and the $\frac{1}{60}$ of a talent of silver."

It may be noted, however, that one writer (Mr. Donisthorpe, "A System of Measures") states that the Gothic races brought in the marc of 3,600 G.T. from the beginning, with a Gothic

grain of $(\frac{15}{16})^2$ G.T. (see Table XXXIII.), but I can find no evidence for the existence of such a grain, and it is entirely out of keeping with the systems on which other grains are based. The weight of this Gothic grain would be 0·878 O.G.T.. It seems more probable that they used the half rati of 0·84375 O.G.T. It is, however, very interesting to find that Mr. Donisthorpe makes the half pint of corn (equal to the old half Hon of water) of 4,096 Gothic grains, equal in weight to 3,614 G.T., so that we both make the half pound used by the early Goths to be 4,096 grains. The only authority he gives is this (p. 66): "We know that the Gothic pound contained 8,192 grains ($32 \times 16 \times 16$)," and he assumes that the modern Avoirdupois pound of 7,000 G.T. is the *old* pound (and it is so very nearly with full Troy grains). Now his Gothic grain, according to my standard, is 4 per cent. too high: we must therefore take off from the 3,614 G.T. 4 per cent., or 144 G.T., giving 3,470 G.T., or close on 2,048 rati. This is not, however, a matter which affects weights and measures so much as it affects the history of the Gothic Hon weights, especially with regard to their Indian affinities.

Did the Tower pound of 5,400 G.T. mentioned in the code of Manu come to the Goths at a comparatively late date (fourth or fifth century A.D.) from Babylonia or Alexandria through the pedlars and Jews, or was it with them, from of old, as an Aryan inheritance, as it was with the Aryan invaders of India (say 1,200 B.C.)?

The Merovingian or Occidental Pound (4,860 G.T.).

The Merovingians (*circa* A.D. 500) took over the Occidental pound, 4,860 O.G.T. ($\frac{1}{80}$ Attic talent), which was in use at Constantinople, and formerly in Rome. In doing so they adhered to the Roman multiples (6,912 grains to pound of 5,184 G.T.); so that they introduced a new grain of 6,912 to 4,860 G.T., or 45 wheat grains to 64 G.T. This is the origin of the Tower Mint grain.

Sixteen Tower Mint barley to 15 G.T. ∴ 64 Tower Mint wheat to 45 G.T.

The following is the Merovingian table of divisions of the pound:

MEROVINGIAN MINT WEIGHTS.

	G.T.	Tower Mint Wheat.	Name.
—	16·875	24	Denier.
—	67·5	96	Tremissis.
—	405·0	576	Ounce.
—	3240·0	4,608	Marc.
Occidental pound	4860·0	6,912	Pound.

Mr. E. W. Robertson ("Historical Essays": Standards, 1872) states that at the same time that Constantine originally established the Occidental pound at Constantinople, he also established a heavier pound by $\frac{1}{6}$, of 5,670 G.T., and this statement is entirely borne out by what I have found in the remains of the pound weights of Europe. The marc of this pound is 3,780 G.T., and two marcs will be 7,560 G.T. Take away 5 grains from the double marc, and we have 7,555 G.T., which is the weight of the 2 marc poid de marc of France, given in Kelly's "Cambist" (7,555 English grains). The same grain multiple of 6,912 was again used in this, as with the Merovingians, so that we have thus a new grain introduced—the Paris grain of 0·8203 G.T.

MEROVINGIAN HEAVY POUND.

Poid de Marc. G.T.	G.T.	Paris Grains.	Name.
—	19·687	24	Denier.
—	472·5	576	Ounce.
—	3780·0	4,608	Marc.
—	5670·0	6,912	Pound.
7560·0	7560·0	9,216	2 marcs.

About the time of Offa of Northumbria (time of Charlemagne) the following Austrasian system was introduced north of the Thames. The grain used was that of Merovingians and Carlovingians, Mint Wheat, $\frac{45}{64}$ of the Troy grain.

The pound of 16 solidi is the marc of the Attic mina of 6,480 O.G.T.

CARLOVINGIAN—NORTH GERMANY AND ENGLAND.

45 Troy Grain.	64 Mint Wheat.	
22·5	32	Pfennig (penny), 12 pence to 1 solidus.
180·0	256	Loth (2 shillings of 4 pence each).
360·0	512	Ore of 16 pence. Original standard of Cologne marc of North of England.
2880·0	4,096	Marc, 10 solidi, 8 denarii.
4320·0	6,144	Pound, 16 solidi, 192 pence.
5400·0	7,680	Tower pound, 20 solidi, 12 ounces, 240 pence, or 15 ores. Pondus Caroli Magni, great pound of South of England.
6750·0	9,600	Avoirdupois pound until Henry VIII. Commercial standard. 15 ounces of 20 pence; Libra Mercatoria; King David's pound of A.D. 1419.

After about A.D 1500 the Tower pound acquired the name of "Troy Weight of London," or "London Troyes." King Henry VIII. raised the Tower pound of 5,400 G.T. to 5,760 G.T., Troy pound, and abolished "London Troyes."

Mr. E. W. Robertson gives the three following tables to which I have added the values in Troy grains :

NORTH OF THE THAMES.

Troy Grain.	Mint Barley.	Mint Wheat.	
—	8	12	1 hellar.
67·5	64	96	1 quint. 4 pfennig.
270·0	256	384	1 loth.
540·0	512	768	1 ore of 2 solidi.
2160·0	2,048	3,072	½ marc of 8 solidi.
4320·0	4,096	6,144	1 marc of Vienna. Frison's full marc. 16 solidi.

Wendish (Poid de Marc). England and North Germany.

Troy Grain.	Mint Wheat.	
14·7	21	1 light penny.
59·06	84	1 scilling.
354·37	504	1 ore of 16.
2835·0	4,032	1 marc, 10 solidi, 6 denarii.
4252·5	6,048	1 pound, 15 solidi, 9 denarii.

Sixteen ores of 16 = 8,064 Mint wheat = 5,670 G.T., the pound of Troyes.

Standard of Bavaria, Twelfth Century, from the Time of Charlemagne.

Troy Grain.	Mint Wheat.	
22·5	32	Denarius.
33·75	48	1 scat.
67·5	96	1 double scat, thrysma.
112·5	160	1 saiga (scilling of Wessex).
337·5	480	1 semi-solidus (scilling of Kent).
675·0	960	1 solidus (mancus).
2700·0	3,840	1 half marc of 10 solidi.
5400·0	7,680	1 marc of 20 solidi.
8100·0	11,520	The Babylonian log, 1½ marcs.

G.T.				
270	...	...	...	Solidus, 12 pence.
360	...	...	...	Ore of 16.
540	...	...	...	Ore of 2 solidi.
675	...	...	...	Mancus, 30 pence.

The Denier or Penny.

A word or term for a small unit of money value corresponding to the word "denar," or "denier," is found in England, France, Italy, Moslem lands, and India.

In parts of India the names of the smaller money weights are those of the Lower Roman Empire: "*fals*," "dirhem," "denar" (but the denar itself is an old Roman coin), the "varaha" or "pagoda" (54 G.T.), which has existed since the beginning of weights. With the Moslems the denar is the weight of 64·8 O.G.T., the Attic drachma.

Under the Roman Empire the denarius became gradually debased, and all authorities concur that after the irruption of the western barbarians (about A.D. 476) it finally disappeared.

In England and France the denar or denarius appeared as a new weight in Carlovingian times, of 22·5 G.T., double of the obol of the Ptolemaic pound, or one sestertius, or 10 grains Ptolemaic system (Table XXVII.). Its first appearance in England was in the time of Offa (*circa* 800).

The Carlovingian system, given above, takes the marc of the Moneyer's pound as its pound, dividing it into 12 ounces; or 192 pence, the Moneyer's pound being thus 240 pence.

The Moneyer's Pound or Tower Pound (5,400 G.T.).

The old Saxon money pound, called afterwards the Goldsmith's or Tower pound, was divided as follows in *Mint wheat* grains. The divisions are also given in Mint barley and Troy grains:

Troy Grain.	Mint Grains.		Early Names.	Later Names.	Pence.
	Barley.	Wheat.			
—	6	8	—	1 farthing	—
—	12	16	—	1 half-penny	—
22·5	24	32	1 denier	1 penny	1
270·0	288	384	1 sou	1 shilling	12
450·0	480	640	—	1 ounce	—
5400·0	5,760	7,680	1 livre	1 pound	240

It is not known when the Moneyer's pound first came into use in Britain, but the Mint grains (barley and wheat) by which it was measured appear to have come from the Merovingians.

The Mint grains, barley and wheat, are respectively $\frac{5}{6}$ of the ancient barley and wheat grains, and respectively $\frac{15}{16}$ of the Troy barley and wheat grains. These Mint grains were the standard grains of the Tower of London for many centuries.

The Tower pound is { 5,400 G.T. barley, or 7,200 Troy wheat.
5,760 Mint barley, or 7,680 Mint wheat.

The penny of 22·5 G.T., and the pound of 5,400 G.T. were in England as early as the time of Offa, but the shilling (12 pence), does not seem to have been used in all England until the Norman Conquest. Previously the Tower pound was divided into 15 ores of 16 pence north of the Thames. The division of the money pound into 240 pence appears to have been introduced into Europe by Charlemagne, A.D. 800, using the Mint grains. In the time of Edward I. the money pound was 20 shillings, or 240 pence of 22·5 G.T., and the Commercial pound was 25 shillings (6,750 G.T.). In the reign of Edward III. the money pound began to shrink in weight, and ceased to measure the weight of gold and silver articles.

The Official Pounds in Use in England in Early Days.

The Moneyer's Pound of 5,400 G.T. and the Libra Mercatoria of 6,750 G.T.

There is, even at the present day, much confusion on the subject of the English pounds, recent writers stating that the Troy pound was our early pound, and discarding the libra mercatoria altogether.

The "Warden of Measures," 1872-73, p. 17, states: "From the Statute of 31 Edw. I., 1301, *Tractatus Ponderibus et Mensuris*, it is evident that besides the Tower pound, which, as before shown, contained 5,400 G.T., there was at that time no other legal pound than the ancient merchants' pound (known as the *libra mercatoria*) of 15 ounces, Tower pound, and equal to 6,750 G.T."

"The merchants' pound of 6,750 G.T., established 1270, for all except gold, silver, and drugs, was superseded by Avoirdupois in 1303. The merchants' pound of 7,200 G.T., from France and Germany, was also superseded."

The Troy pound of 5,760 G.T. was established as the monetary pound in 1527, after the Tower pound of 5,400 was abolished; but as there were 5,760 *Mint grains* to the Tower pound, it would appear to superficial observers a continuous use of a weight of 5,760 grains, it not being noticed that the weight of the grain was changed in 1527 from the Mint barley to the Troy grain, as 15 : 16.

"Up to the reign of Henry VIII. the legal weight in use consisted of the old Saxon pound, called afterwards the Goldsmith's or Tower pound." "The pound weight of silver was the original pound sterling, and, in fact, up to the time of Edward I. all money payments were made in silver, computed by weight. It has been already stated that existing records of the Exchequer show that up to the reign of Edward III. the weight of the gold and silver plate is expressed in the old money weight of pounds, shillings, and pence."

"The system of weight is sometimes called in the records 'pois della tor,' at other times 'pois d'orfevres,' or 'monaye des gross.' The latest date at which the Tower, or Goldsmith's, or Moneyer's weight, is mentioned is 7. Richard II., after which date the weights are for the most part stated in pounds and ounces; but the term 'pois de troie' first appears, as applied to this weight, in an inventory of the King's gold and silver plate in the first year of Henry IV." (p. 16).

It would appear, then, that "pois de troie," or *Troy weight,* is the old name for the British Mint or money weight, possibly derived from France, and that when Henry VIII. established the Dutch or German weight of 5,760 G.T. (pound of Almamun), and thus increased the Tower pound as 15 : 16, he gave it the old name of Troy weight.

Mr. Robertson on this subject, speaking of the shrinking of money pound about the reign of Edward III., says :

"Thus, as the sterling pound shrank into a money of account, the standard of weight kept at the Tower seems to have gradually acquired the name of 'Troy weight of London,' or London Troyes,' to distinguish it from the current pound; probably because the standard weight in France, the Paris 'pois de marc,' was known as 'the pound Troy of Paris,' or 'Paris Troys,' to distinguish it from the 'Livre Parisis' or 'Livre

Tournois.' London weight, or the Troy pound, was raised by Henry VIII. to its present standard in 1526, and thus the true sterling standard, or Tower pound, latterly known as "London Troyes," became a thing of the past, just about the time when Charles V. confirmed its equivalent at Cologne, as the monetary standard of Germany.

The Libra Mercatoria and Avoir du Pois.

The term "Avoir du pois" is merely the name for the two Hons of 6,750 and 6,912 G.T., which were constantly following each other.

They were as 125 : 128 originally, but the first having lost 1 per cent. in weight, they became as 6,750 : 7,000, or as 27 : 28.

The name was spelt in various ways: "Havr-du-pois," "Aver de pois," "Haber-de-pase," "Habredye-poyse"

The term applies to heavy goods from beyond the seas; an "aver" is an old English word for goods.

The Avoirdupois pound was 6,750 G.T. Mr. Robertson states: "By the substitution of the Winchester for the London standard the pound of 15 or of 20 pennyweight, or the old weight for Avoir du pois (=6,750 G.T.) was established as the basis of reckoning in the place of London Troys or the London pound of 5,400 G.T." The Winchester bushel gave a pound of 6,742 G.T., the bushel of Elizabeth 6,726 G.T.

The Wardens of the Standards (1872-73) state: "The exact period of introduction into the country of Avoir du pois is not known, but there is no record of its being used before the reign of Edward III." "It was first authorized by Statute 1532."

The manner in which the multiple of seven came into the Avoirdupois weight system is very evident.

The ton Avoirdupois was made to coincide with 100 poid de marc in the following manner:

112 pounds of the Libra Mercatoria (6,750 G.T.) = 756,000 G.T.
100 „ „ Poid de marc (7,560 G.T.) = 756,000 G.T.

Therefore 1 hundredweight Avoirdupois of about Edward III. was clearly 100 pounds poid de marc.

This is about 1 per cent. in excess of 60,000 C.I. to the Gudean ton, or $\frac{6}{7}$ double cubit cubed.

We have no evidence at present to show how the Avoirdupois measures were raised to their present weight as 27 : 28 (but see Chapter VI.).

An early British hundredweight may have been 100 pints of the old Hon, 2,000 pints of which go to the double cubit cubed. It is said to have been in use before the time of Edward I. to Edward III.

Suggested Early British Weights.

	Pints.		Ounces.	C.I.	Cubic Foot.	Old Hons.	Revised Hons.
	Number.	O.G.T.	Number.			Number.	Number.
Ounce	·05	432	1	—	—	—	—
Revised hon ...	—	6,750	—	—	—	—	1·0
Old hon	·8	6,912	16	27·648	—	1·00	—
Old pint	1	8,640	20	34·56	—	1·25	—
Stone	12½	108,000	250	432·0	—	—	16·0
Quarter hundredweight	25	216,000	500	864·0	—	—	32·0
Cubic foot	50	432,000	1,000	1728·0	1	62·5	64·0
Hundredweight ...	100	864,000	2,000	3456·0	2	125·0	128·0
Way	200	1,728,000	4,000	6912·0	4	250·0	256·0
Double cubit cubed	2,000	17,280,000	40,000	69120·0	40	2500·0	2560·0

The Troy Pound of 5,760 G.T.

The Troy pound (23·04 C.I.) is $\frac{1}{100}$ of the 9-inch cylinder, and was in existence in Babylonia at least 1,000 B.C. (Chapter III.).

Its pint of 28·8 C.I. belongs to the Old English Wine measure (reckoned at 28·875 C.I. in 1824), and was in existence as early as the reign of Edward I.

The Troy pound came into general use in Moslem times as $\frac{1}{125}$ Black double cubit cubed (the Arabic rotl), and is said to have been presented to Charlemagne by the Khalif Harûn al Rached A.D. 800; but it is quite as probable that it was the Occidental pound of the heavier kind that was presented—viz., 5,670 G.T. (differing only 90 G.T. in weight).

The pois de troie was probably the weight of 5,670 G.T. in the reign of Edward III., and when Henry VIII. abolished the Tower pound and substituted the Arabic rotl of 5,760 G.T. it acquired the name of the Troy pound. The matter, however, is obscure.

TABLE XXIX.

COMPARISON OF OLD ENGLISH MEASURES OF CAPACITY. (TAKEN FROM G. BUCHANAN'S TABLES.)

Gallons.	Pint.	Old English Dry Winchester Measure. Pint, 33·6 C.I. (Originally 33·75 C.I. ?).	Unconformable Numbers.	Old English Wine Measure. Pint 28·875 C.I. (Originally 28·8 C.I. ?).	Unconformable Numbers.	Old English Beer and Ale Measures. Pint, 35¼ C.I. (Originally 36 C.I. ?).
—	1	4 gills = 1 pint.	—	4 gills = 1 pint.		
—	2	2 pints = 1 quart.	—	2 pints = 1 quart.	—	2 pints = 1 quart.
—	4	2 quarts = 1 pottle.	—	— —	—	— —
1	8	2 pottles = 1 gallon.	—	4 quarts = 1 gallon.	—	4 quarts = 1 gallon.
2	16	2 gallons = 1 peck.	—	— —	—	— —
8	64	4 pecks = 1 bushel.	—	— —	9	8 gallons = 1 firkin.
32	256	4 bushels = 1 combe.	—	— —	—	4 firkins = 1 barrel.
64	512	2 combes = 1 quarter.	63	64 gallons = 1 hogshead.	1½	2 barrels = 1 {hogshead. puncheon.
128	1,024	2 quarters = —	126	128 gallons = 1 pipe or butt.	—	2 {puncheons hogsheads} = 1 butt.
256	2,048	4 quarters = 1 tun or chaldron.	—	2 pipes = 1 tun.	—	2 butts = 1 tun.

NOTE.—There was uncertainty as to the content of the wine gallon until A.D. 1700, when it was settled by authority of Parliament. Probably the Dry Measure is from the Euboic (see Table III.), and the Wine and Beer measures are from the Yard cylinder, the Wine pint weighing a pound ($\frac{4}{5}$ of Beer pint): "and 8 pounds do make a gallon of wine," as laid down in Act of Henry III. In the Wine measure, 128 gallons to a pipe are substituted for 126 gallons. In the Beer measure 8 gallons to a firkin are substituted for 9 gallons, and 2 barrels to a hogshead substituted for $1\frac{1}{2}$ gallons.

Irish Weights.

The early Irish weights appear to have come from Rome.

The tende (Petrie's round Towers) weighed 10 pounds of 6,912 grains of corn = 69,120 grains, or 120 ounces (ungas) of 576 grains.

Another computation is 60,400 grains of wheat, or 72 ounces of 504 grains = 36,288 grains.

This pound of 6,912 grains is probably the Roman pound of 5,184 O.G.T.

"Origin of Currency," p. 180, gives the Irish system as follows:

	O.G.T.	"Origin of Currency."
	$\frac{3}{4}$	1 grain wheat.
	6	8 pin ginn.
Scruple	18	24 screapall.
Ounce	432	576 unga.
Roman pound ...	5,184	6,912

There were 32 crosogs to an unga, giving 13·5 O.G.T. to a crosog, equal to one-fourth of a ducat. Thus, the original Irish weights were probably binary, on a standard crusog of 8 rati (see Table I.).

The English Mile.

This is founded on a compromise between the yard of 36 inches, and the Belgic double cubit of 39·8 inches; the original Gudean cubit, 39·5 inches, $\frac{1}{40000000}$ of the earth's circumference having been given up; this makes the English mile 1,760 yards instead of 1,755, and 80,000 digits of ·792 inch; consequently it is not an integral portion of the earth's circumference.

The two systems coincide at the furlong: 10,000 digits of ·792 inch equal 11,000 digits of ·72 inch, giving a furlong of 7,920 inches = 22 yards.

The 22 yards to a furlong follows the Pyramid system, and does not now serve any useful purpose for linear measurements.

A more simple system, and one connected with the nautical mile, would be of advantage.

The nautical mile is 2026·6 yards, or 6,080 feet, or one minute of arc; the ancient geometric mile or minute of arc was 2,020 yards.

It is suggested that the English mile should be 2,000 yards, with a furlong of 250 yards, the fathom 2 yards.

To change nautical miles into English miles add 1 per cent. for all practical purposes.

The Moslems have derived from the Persians the digit ·79, probably ·7901, and the English system has ·792 inches from the combination of the cubit 19·8 inches with the yard. The three are given below:

TABLE XXX.

From Anglo-Saxon Times. English System: A Compromise.				Original (100) System.				Moslem System of Almamun (from the Sexagesimal System).			
Name.	Links.	Yards.	Inches.	Name.	Digit.	Yards.	Inches.	Name.	Digit.	Cubit.	Inches.
Digit	—	—	0·792	Digit ...	1	—	0·7901	—	1	—	0·7901
Link	1	—	7·92	—	—	—	—	—	—	—	—
—	$2\frac{1}{2}$	—	19·8	Cubit ...	25	—	19·75	—	25	1	19·75
—	5	—	39·6	Double cubit	50	—	39·5	—	50	2	39·50
Fathom ...	10	—	79·2	Fathom ...	100	—	79·01	—	—	—	—
Pole or perch ...	25	$5\frac{1}{2}$	198·0	—	—	—	—	—	—	—	—
Chain	100	22	792·0	—	—	—	—	—	—	—	—
Furlong ...	1,000	220	7920·0	Furlong ...	10,000	219·4	7901·2	—	—	—	—
Mile	8,000	1,760	63360·0	Mile ...	80,000	1755·2	63209·6	Mile ...	90,000	3,600	71109·0

TABLE XXXI.

TABLE OF THE VARIOUS GRAIN WEIGHTS USED IN EARLY TIMES TO THE YEAR A.D. 800; GIVING THE WEIGHT OF EACH GRAIN IN GRAINS TROY, AND THE NUMBER TO A PURANA OF 54 O.G.T. AND TO A REVISED HON OF 6,750 O.G.T.

	Name of Grain.	Weight of Grain.	Number of Grains to a—		Remarks.
		O.G.T.	Purana.	Revised Hon.	
1	Rati, or gunga	1·6875	32·0	4,000	Original rati grain.
2	Barley (Babylonian ; Roman)	1·125	48·0	6,000	In early use, Babylonia and Egypt.
3	Wheat ,, ,, ...	0·84375	64·0	8,000	Assyria, Rome, Goths, Teutons.
4	Barley (Greek)	1·08	50·0	6,250	Early Attic.
5	Assyrian and Early Hebrew	0·6	81·0	10,125	Assyria, 800 B.C. and earlier.
6	Used in Babylonia (Persian ?) during Captivity	0·675	80·0	10,000	Babylonia, after 500 B.C.
7	Barley (Troy ; East Babylonia)	1·0	54·0	6,750	Introduced into Europe by Phœnicians.
8	Wheat ,, ,, ...	0·75	72 0	9,000	—
9	Barley (Tower Mint)	0·9375	57·6	7,200	Carlovingian ; Merovingian.
10	Wheat ,, ,, ...	0·703125	76·8	9,600	London Troyes.
11	Barley (Double Mint ; Moslem)	1·875	28·8	3,600	Used by Moslems.
12	Barley (Moslem, Herbelot)	0·9	60·0	7,500	V. Queipo 60 and 403.
13	Wheat (Moslem, Makrizi)	0·675	80·0	10,000	
14	Rati, increased as 27 : 28 (Early Pathan Kings)	1·75	—	—	"Orientalia Numismata."
15	Double mint barley, increased as 27 : 28 (Akbar)	1·9375	—	—	,, ,,
16	Gothic grain (Donisthorpe)	0·8789	—	—	Pp. 83, 84.
	Probably Babylonian wheat	0·84375	64·00	8,000	Probably half rati.
17	Grain of poid de marc, $\frac{7}{8}$ (Mint wheat) ...	0·8202	—	—	The Paris Grain, Kelly.

It will be observed that our present English system exactly follows the ancient system, if we take one-tenth of a link as the digit, and there are all reasons for supposing that it has existed since Saxon times. At one time the mile may have been increased to 10 furlongs in the North of England and Scotland. In the north-west was the Gallic league of about 2,800 yards and in London there was a mile of 5,000 feet, probably from the Roman mile.

Some writers have assumed that Gunter, in 1620, invented the chain measure, because he invented the measuring instrument called the "chain." The acre, however, from very early times, has been a strip of land measuring 1 chain by 10 chains (or furrow-long; furlong).

TABLE XXXII.

FORMATION OF THE VARIOUS POUNDS FROM THE THREE OUNCES, 432, 450, AND 480 O.G.T.

	Ounces.								
	1	11½	12	15	16	18	20	20½	22·5
Original half ounce ...	432	4,860 Solonian Byzantine	5,184 Roman	6,480 Attic	6,912 Old Hon	7,776	8,640	8,748	9,720 Tron Scotch
Ounce of Tower pound ...	450	5062·5 Roman	5,400 Tower	6,750 Revised Hon	7,200 Tower Rotl	8,100 Log	9,000 Euboic	—	—
Troy ounce ...	480	5,400 Tower	5,760 Troy	7,200	7,680 Tron Scotch	8,640	9,600	9,720	—

FORMATION OF VARIOUS POUNDS FROM THE DUCAT, 54 O.G.T.

Old Hon	128 × 54 O.G.T. = 6,912 O.G.T.
Revised Hon	125 × 54 ,, = 6,750 ,,
Tower pound	100 × 54 ,, = 5,400 ,,
Attic pound	120 × 54 ,, = 6,480 O.G.T.
Roman pound	96 × 54 ,, = 5,184 ,,

FORMATION OF THE VARIOUS POUNDS FROM $22\frac{1}{2}$ O.G.T. (THE ENGLISH PENNY).

Scoteh tron ...	432 × 22·5 O.G.T.	= 9,720 O.G.T.	$20\frac{1}{2}$ Troy ounces.
	384 × ,, ,,	= 8,640 ,,	$20\frac{1}{2}$ Old ,,
Moslem rotl ...	320 × ,, ,,	= 7,200 ,,	16 Tower ,,
Revised hon ...	300 × ,, ,,	= 6,750 ,,	15 ,, ,,
Attic pound ...	288 × ,, ,,	= 6,480 ,,	15 Old ,,
Troy ,, ...	256 × ,, ,,	= 5,760 ,,	12 Troy ,,
Tower ,, ...	240 × ,, ,,	= 5,400 ,,	12 Tower ,,

PREHISTORIC REMAINS.

(See Fergusson's "Rude Stone Monuments," and Petrie's "Inductive Metrology.")

It might naturally be assumed that the cubits or units of measure used by the builders of the prehistoric remains would be the early cubits with which mankind were provided when they left the central home near Lake Van—viz., the cubit of a man, and the bushel cubit. But though I find a close relation between all the cubits of prehistoric remains all over the world, I cannot find any connection between them and the original cubits, or, indeed, with any early cubits.

My investigation of early weights and measures seems to bring out very clearly :

1. The prehistoric remains of the world are comparatively recent, certainly more recent than the twelfth Egyptian dynasty, and probably dating from before the sixteenth Egyptian dynasty, the earliest originating in the vicinity of Babylonia, and others many centuries more recently in East Asia, Europe and America.

2. The various cubits used all belong to one series, and are closely allied in a simple proportion.

3. They are not derived directly from a cube side of a unit volume, as other cubits are, but are proportions of the 18-inch measure.

4. One race has done the work all over the world, and that one race is the one which at the time of the Hyksos in Egypt brought in the use of the khar (or 18-inch measure). This same race, about the fourth century, A.D., appears to have brought the 18 inch cubit, 13·2 inch (Belgic foot), and link of 7·92 inches into England from the East ; this Belgic foot being also called the

TABLE XXXIII.

RECORD OF ALL THE OLD POUNDS LIKELY TO HAVE BEEN IN USE AT THE END OF THE ROMAN EMPIRE, AND THE NUMBER OF GRAINS IN WHICH THEY MAY HAVE BEEN DIVIDED DURING MEROVINGIAN AND CARLOVINGIAN PERIODS.

The Phœnician pound of 7,500 G.T. is given here, but it is unconformable. It will be seen that they are in three sets, in the proportions of 100, 120, and 90, and that in each set are four pounds, in the proportions of 60, 62·5, 64 and 80.

Pound.	Proportions, in Three Sets.	Troy—		Mint—		Uncertain.	Ancient—		Rati. $\frac{27}{16}$	Ounce. $\frac{1}{12}$
		Barley. 1 G.T.	Wheat. $\frac{3}{4}$	Barley. $\frac{15}{16}$	Wheat. $\frac{45}{64}$	Gothic. $(\frac{15}{16})^2$	Barley. $\frac{9}{8}$	Wheat. $\frac{27}{32}$		
Old pound (Tower) ...	60	5,400	8,100	5,760	7,680	6,144	4,800	6,400	3,200	450
	62·5	5,625	7,500	6,000	8,000	6,400	5,000	—	—	468·75
Troy	64	5,760	7,680	6,144	8,192	—	5,120	—	—	480
Tower (Commercial) ...	80	7,200	9,600	—	—	8,192	6,400	—	—	—
Attic	60	6,480	8,640	6,912	9,216	—	5,760	7,680	3,840	540
Revised Hon	62·5	6,750	9,000	7,200	9,600	7,680	6,000	8,000	4,000	562·5
Old Hon	64	6,912	9,216	—	—	—	6,144	8,192	4,096	576
Attic (Commercial) ...	80	8,640	11,520	—	—	—	—	—	—	—
Byzantine	60	4,860	6,480	5,184	6,912	—	4,320	5,760	2,880	405
Middle Roman	62·5	5062·5	6,750	5,400	7,200	5,760	4,500	6,000	3,000	421·8
,, ,, ...	64	5,184	6,912	5529·6	—	—	4,608	6,144	3,072	432
Late Roman	80	6,480	See Attic		9,216	—	—	7,680	—	—
Gudean pound	—	7,500	—	—	—	—	—	—	—	—

MARKS.—(These are all $\frac{2}{3}$ of the pound.)

NOTE.—England and Berlin used Tower pound or Tower mark with *Mint wheat* (7,680 and 5,120). Gothic races used Tower mark with Gothic $(\frac{15}{16})^2$ (4,096), or Ancient wheat. Spain used Roman mark of 3,456 with Troy wheat (4,608), and Ancient wheat (4,096). Italy used Roman pound (5,184) with Troy wheat (6,912). Austrasians used Eastern Roman pound and mark of 4,860 and 3,240, with Mint wheat (6,912 and 4,608). Holland used 5,760 with Troy wheat.

Drusian foot of the Tungri, records of which appear in Roman history about 30 B.C.

The curious connection of prehistoric measures with one another all over the world must have struck many investigators.

Mr. F. Petrie ("Inductive Metrology," p. 127) says of the Indian remains: "The fact of similar Indian and English remains both being very usually in terms of 6, 12, 18, etc., feet (as noticed by Colonel Meadows Taylor) does not necessitate their having been constructed with the same unit; and it so happens that the circles of 6, 12, 18, and 36 feet are 4, 8, 12, and 24 hasta; and also 18 feet is 10 and 36 feet 20 of the commonest prehistoric British unit (21·6 inches), and the 6 and 12 feet are $\frac{1}{3}$ and $\frac{2}{3}$ of this quantity. Thus, the resemblance need not lead us astray, as it is shown to be accidental by inductive examination of the kindred remains independently of each other."

At page 144 Mr. Petrie says: "It is astonishing to find that the average error made in laying out the earth-works by the ancient British was not more than that made by the civilized and cultivated Assyrians."

At page 145 he points out that the Assyrian cubit (21·3 inches) found in Egypt, Persia, Italy, and Sardinia, is also identical with the early Christian Irish unit, and is the commonest unit of prehistoric remains and the unit of Mexico; and he goes on to speak of the exact identity of the unit of the North American mound-builders with the Hebraic and Persian unit of 25 inches.

Mr. J. Fergusson is impressed with the same idea when he says (note 2, p. 91, "Rude Stone Monuments"): "I am almost afraid to allude to it, even in a note, but it is a curious coincidence that nearly all the British circles are set out in two dimensions. The smaller class are 100 feet, the larger are 100 metres in diameter."

The Prehistoric Builders' System.

The following is the system, so far as I am able to judge. The unit or base was the fathom of 72 Imperial inches, divided into 4 cubits of 18 inches, and further iuto 80 and 100 digits.

Taking 80 digits to the fathom, they are in the following

proportion: 100, 83·3, 75, 96, 86·4, 76·8, 90, 81, 80, 120, giving the following cubits (in Imperial inches): 22·5, 18·75, 25, 16·875, 21·6, 19·44, 17·28, 11·52, 20·25, 18·225, 19·8, 18·27, 18, 27, 12. All these cubits are in definite proportion to one another, and have no connection with any of the building cubits.

Derivation of the 18-Inch Cubit.

In Table XVI., "The Ancient Cubit," I propose a system which I term $\frac{2}{3}$ Babylonian (Grecian and British). $\frac{2}{3}$ Babylonian cubic foot (2,592 C.I.) equals 1,728 C.I., the British cubic foot. I have shown in this work (pp. 62, 65, 66, 70, and 72) that the cubic foot of either 1,728 or 1749·6 C.I. (80 : 81) existed in Greece, Italy, Egypt, and Assyria, but the place and date of the origin of the 18-inch cubit has yet to be discovered.

TABLE XXXIV.

Rude Stone Monuments All Over the World.

From Fergusson's "Rude Stone Monuments" and F. Petrie's "Inductive Metrology." Dimensions of cubits in inches. Digit of 0·72 inch common to all cubits.

Proposed Standard Dimensions.					Inches.	Inductive Metrology = I.M. Rude Stone Monuments = R.S.	Page.
Digits. 80 to 6 Feet. 0·9 Inch.	Digits. 100 to 6 Feet. 0·72 Inch.	Fathom Inches.	Foot Inches.	Cubit Inches.			
100	125	90·0	15	{ 22·5 / 45·0 }	22·56	England	
—	—	—	—	—	22·42	France } Barrows, Cromlechs	120 I.M.
—	—	—	—	—	25·83	Scotland	
—	—	—	—	24 = 540·0	537·0	Hawaiian : Ancient buildings	125 ,,
—	—	—	—	24 = 540·0	531·0	Oberea ; Tahiti : Mound	125 ,,
—	—	—	—	—	1050–1080	North America : Earthworks	123 ,,
—	—	—	—	—	980·0	Gorwell, Dorset	113 ,,
—	—	—	—	—	323·0	Winterbourne Abbas, Dorset	113 ,,
83·3	104·16	75·0	—	18·75	18·8	England and Scotland : Terraces... ...	117 I.M.
—	—	—	0.46875	25·0	25·2	North America	{ 123 ,, / 145 ,, }
75·0	93·75	67·5	11·25	16·875	8·4	Fardell : Ogham stone	121 I.M.
—	—	—	—	—	16·66	Elora	126 ,,
96·0	120·0	86·4	14·4	21·6	21·32	France	
—	—	—	—	—	21·48	England } Barrows, Cromlechs, etc. ...	119 I.M.
—	—	—	—	—	21·34	Scotland	
—	—	—	—	× 9·6 = 20·73	19·50–20·64	Trilethons.	
—	—	—	—	× 12·0 = 25·92	25·92	Stonehenge	91 R.S.M.

86·4	108·0	77·76	12·96	19·44	12·8	Denmark: Runic	120 I.M.
—	—	—	—	12·96	{12·5, 12·6 / 12·72}	North America: Mould builders... ...	124 ,,
—	—	—	—	$\frac{8}{10}$ 15·552	15·58	Sinai	121 ,,
76·8	96·0	69·12	11·52	17·28	11·68	Stonehenge and Dorset: Barrows ...	118 I.M.
—	—	—	—	—	11·58	Stonehenge: Circle	,,
—	—	—	—	—	11640·0	,, ,, ...	,,
—	—	—	—	$\frac{1}{6}$ 2·88	2·92	Jutland: Ribe	121 ,,
90·0	112·5	81·0	13·5	20·25	20·41	Dorset: Barrows (long)...	117 I.M.
—	—	—	—	6·75	6·76	Copan: Architectural remains and idols ...	125 ,,
—	—	—	—	—	6·67	Africa: Signs	121 ,,
81·0	101·25	—	—	6·075	6·11	Ceylon: Old palace	128 ,,
54 0	—	—	—	18·225	18·38	Dekkan: Rude stone	127 ,,
88·0	110	79·2	13·2	19·8	39·60	(100 metre circles)	91 R.S.M.
—	—	—	—	$\frac{8}{10}$ 15·84	15·95	Dartmoor	118 ,,
—	—	—	—	$\frac{1}{4}$ 4·95	4·94	Rooves Moor: Ogham Stone	121 ,,
—	—	—	—	$\frac{1}{4}$ 3·3	3·29	Dorset and Sussex: Circles	117 ,,
—	—	—	—	13·2	13·2	Early Christian Churches	103 ,,
		Standard	Standard	Standard			
80·0	100	72·0	12·0	18·0	1200·0	Small 100 feet English circles	91 R.S.M.
120·0	150	108·0	18·0	27·0	17·82	Ellora	120 I.M.
—	—	—	—	—	18·38	Dekkan: Rude stone	127 ,,

See Oppert's deduction as to Assyrian cubit, 21·6 inches, p. 69 I.M., and also building cubits of 27 inches, Egypt and Cyclopic remains, 11·53, Greece and Italy.

CHAPTER V

THE WEIGHTS AND MEASURES OF INDIA AND THE FAR EAST

Before reviewing the weights and measures of India, it is necessary first to observe the condition of those of the various nations or races of the Far East.

We may assume that up to some date, still uncertain (say, 1200 B.C.), all Eastern nations have used the same primitive weights on the Ganda system (p. 6)—viz., India, Malaya, Burmah, Siam, Eastern Archipelago, China, and Japan. And if the less civilized portions of the countries are examined these primitive weights will still be found.

The principal succeeding influences are as follows:

1. The Aryan Invasion, with the Tower pound (or dharanah of Manu), and a unit heavy weight of 640 Tower pounds, equal to 500 old hon.

2. The irruption of a race from Babylonia increasing the Tower pound to the Troy pound, as 15 : 16.

Of the first we have instances at Rangoon, Pegu, and other places:

The Candy.		O.G.T.	Lb. Av.
Standard weight...	500 old hon, or 640 dharana (Tower pounds of 5,400 O.G.T.	= 3,456,000	= 493·7
Pegu	15,000 ticul ($237\frac{1}{3}$ O.G.T.	= 3,560,000	= 508·5
Rangoon	15,000 ticul (238 O.G.T.)	= 3,570,000	= 510·0

Of the second we have the following instances, where all the subdivisions have been increased as 15 : 16:

TABLE XXXV.

	Tale.	Proposed Original Standard.		Raised Standard O.G.T.	Japan.	China.	Batavia.	Siam.	
		Rati.	O.G.T.						
Cash	$\frac{1}{1000}$	0·32	0·54	0·576	0·568	0·583	—	—	—
Candareen ...	$\frac{1}{100}$	3·2	5·4	5·76	5·68	5·83	—	—	—
Mace	$\frac{1}{10}$	32·0	54·0	57·6	56·8	58·3	—	—	—
Tical	$\frac{1}{4}$	80·0	135·0	144·0	—	—	—	226·0	—
Tale	1	320·0	540·0	576·0	568·0	583·3	590·0	904·0	—
Catty	16	5120·0	8640·0	9216·0	9100·0	9333·3	9450·0	18000·0	—
Pical	1,600	512000·0	864000·0	921600·0	910000·0	933333·3	945000·0	904000·0	160 lb. Troy
Candy	6,400	2048000·0	3456000·0	3686400·0	—	—	—	—	—

When the British system of India was established (1821), founded on old Indian weights, the following table was approved. Its base is a man of 100 dharana (3,200 Rati), raised from 5,400 to 5,760 O.G.T., thus following the later system mentioned above.

TABLE XXXVI.

	Proposed Original Standard Base. O.G.T.	British Scale.		
		British Rati, 1·875 O.G.T.	G.T.	
Rati (British) ...	—	1	1·875	The British Rati is the Moslem Rati of columns II. and III., Table XXXVII., raised from original Rati as 9 : 10.
Masha „ ...	—	8	15·0	
Tola	168·75	96	180·0	
Chattach	843·75	480	900·0	
Seer	13,500	7,680	14400·0	$2\frac{1}{2}$ lb. Troy.
Man	540,000	307,200	576000·0	100 lb. Troy.

EAST INDIES.

Early Records of Weights and Measures.

All modern works on Indian Weights and Measures quote the essay of Mr. A. T. Colebrooke, "Asiatic Researches V.," (p. 91), for the ancient metrology of the Hindus.

In this essay, Mr. Colebrooke gives the results of his inquiries into the various records, which he quotes from the work of Gopála Bhatta, on "Numbers and Quantities" (a comparatively modern writer).

Colebrooke's essay shows clearly that the ancient Hindu systems were binary and Ganda, and based on the Rati seed as a unit, but there is no record of the actual weight. The use of the Pala (320 Rati), instead of 32 Rati as a unit, indicates a somewhat late date for the records.

He accepts Sir William Jones's average of $1\frac{3}{16}$ G.T. as the real weight of the Rati, which average is so far short of the averages of more recent authorities that General Cunningham proposed to substitute $1\frac{5}{6}$ G T. for $1\frac{3}{16}$.

Kelly's "Cambist" (1821) gives numerous tables of weights in India, and makes the Purana, of 32 Rati, at from 50 to 56 G.T.

Mr. Thomas gives only the Moslem value of the Varaha in 56 G.T., both in "Numismata Orientalia" and in "Pathan Kings."

Colebrooke also gives a fictitious value of $2\frac{3}{16}$ G.T. to the Rati as being in common use, and Don V. Queipo gives the value of the Rati at 0·14553 gramme (2·244 G.T.) from Gopàla Bhatta.

We thus have the following for the

Value of the Purana.

		Hindus.		Moslems.
Colebrooke's "Essay"	$48 \times$	$1\frac{3}{16}$ G.T. =	57 G.T.	—
	$32 \times$		38 „	
	$24 \times 2\frac{3}{16}$	„ =	52·5 „	—
Don V. Queipo ...	$24 \times 2{\cdot}244$	„ =	53·856 „	—
Kelly's "Cambist"...	average	=	53 „	—
Mr. Thomas ...	—		—	56 G.T.
Standard deduced from double cubit cubed			54 „	56 G.T.

The weights and measures of India appear to be in a very tangled condition, but the principal cause of confusion has been the introduction of the number 7 by the Moslems as a multiple, and the change in some weights as 15 : 16 and as 9 : 10.

The changes up to the time of the Moslem invasion are simply those that have happened elsewhere, but the Moslems introduced very special changes. The following are the several influences, with approximate dates :

In early days : (1) The original ganda and binary rati weights, with the purana (32 rati) as unit.

1200 B.C. : (2) Aryans or Hindus brought in the (80) and (100) systems with the dharana of 5,400 G.T. and revised Hon of 6,750 G.T., all over India to Ceylon.

600 B.C. : (3) Scythic Turanian races came through Northern Passes with old Hon of 6,912 G.T.

300 B.C. : (4) Greeks brought in Attic system to West India.

10 B.C. : (5) The Roman pound brought into Bactria and North-West India by Greeks.

A.D. 500 : (6) Rude stone builders of Dekkan swept over India and the East, increasing the weights as 15 : 16, introducing the Troy pound.

A.D. 1200 : (7) Pathan Moslems bring in rotl of 7,200 and 7,000 G.T., and multiple of 7, and increase weights as 9 : 10.

A.D. 1500 : (8) Change in weights under Shir Shah and Akbar ; and introduction of the Dam (324 G.T.).

A.D. 1800 : (9) Changes by British, *en rapport* with Hindu-Moslem usages.

The best records of Aryan influences are in Madras, because the rude stone builders and the Moslems have changed the weights and measures in Central and Northern India.

The Aryan money pound has completely disappeared, and in its place in Bombay and Madras is found the 2,560 rati (half a pint). In Bengal the money weight is a Tolah of 225 (224·5) G.T., $\frac{5}{4}$ of a rupee of 180 G.T., and 320 to a rotl of 7,200 G.T. In Central India is the Hon—6,750, 6,912, and 7,000 G.T.

NOTE.—When the Moslems arrived in India with the Troy grain it had probably already lost 1 per cent. of its weight, and the terms G.T. and O.G.T. cannot be used with any certainty in many cases.

The Three Base Weights.

There are three weights on which the weights and measures and coins of India are based :

1. The Purana, 32 rati } Ancient.
2. The Karsha, 80 rati }

3. The Sataractica or Tanka, 100 rati ; comparatively modern. Mr. Thomas ("Numismata Orientalia," p. 68) states that the archaic purana can be traced back, as a money weight, twenty-five centuries ; it reappears in the money of the Brahmanic sovereigns of the Punjáb and Northern India in the ninth century of our era, and runs through the entire issues of their Rájpût successors, from whom it passed to the Moslem conquerors in A.D. 1191, and continued till 1488 under the name of "tank," and has come down to the present day as the "varaha," or "pagoda." The weight is given as quite up to 56 G.T. Kelly's "Cambist" gives the weight as from 52 to 56 G.T. I deduce the standard to be 54 O.G.T. for Hindus and 56 G.T. for Moslems.

The karsha of 80 rati (the kat of Egypt), in its earliest form, appears as the copper paṇa of Manu ; but it also goes back to the time of the Greek invasion of Western India, and continued up to A.D. 1324, and is still to be found as a division of the weights of Bombay and Madras.

The sataractica or tanka of 100 rati was probably introduced by the Vedic Aryans, and taken over by the Moslems ; it is found as a Mint weight up to A.D. 1324, and from thence to our time. It was the origin of the tola, or rupee, and its standard value is 168·75 O.G.T. for Hindus and 175 G.T. for Moslems (as 27 : 28), the Moslem rati having a greater weight. In later times it rose to 180 G.T., the rati being raised also.

In later times the tola was computed at 96 rati.

Gold, Silver, and Copper Weights, from Code of Manu.

Silver.

2 Rati = 1 Máshaka.
32 „ = 1 Dharaṇa or Puraṇa.
320 „ = 1 Ṣatamána.

Gold.

5 Rati = 1 Másha.
80 „ = 1 Suvarṇa.
320 „ = 1 Pala or Nishka.
3,200 „ = 1 Dharaṇa.

Copper.

80 Rati = 1 Kárshapaṇa.

It is to be noted that the table of the code of Manu only relates to gold, silver, and copper weights; but the Aryans had also commercial weights, no doubt the revised Hon of 6,750 O.G.T., and the bushel measures.

The Weight of the Rati in India.

The original weight, as used by the Hindus and Aborigines of India, I take to be the same as in Europe—viz., $\frac{27}{160}$ O.G.T., or 1·6875 O.G.T., and amongst the Moslems as 1·75 G.T. This latter weight (= 1·75) is taken by Mr. Thomas in his work on weights and measures of India. These two weights are as 27 : 28, if the 56 grains are taken as old grains Troy.

The reason of the difference appears to be due to the use of the Troy grain by the Moslems and the multiple of 7.

The Moslems came to India using a multiple of 7 and the Troy grain; if they wished to adhere to the 32 rati, or 54 G.T., they could only do so by raising the rati or lowering the grain Troy, and they chose the former. And 56 G.T. is the nearest approach to the unit they required, raising the rati from 1·6875 to 1·75 G.T. The result is that the revised hon of 6,750 G.T. became exactly 7,000 G.T.—equal to our Avoirdupois pound; and the question presents itself whether the Moslems did not already use the 56 G.T. for the puraṇa whilst in Europe, and thus pass it on to Western Europeans, for we find in Egypt (Chapter VI.) that there also was a pound of 7,000 G.T.

Indian Weights and Indian Measures.

The general view of writers is that owing to conflicting introductions of measures by various races from the North-West and East, the people were forced to go by weight only.

This, however, is not a correct view. Measures of capacity are still to be found all over India, and in all the records of weights and measures, except the Code of Manu, measures are to be found.

The measures in Madras were cylindrical in 1821 (Kelly's "Cambist"), and Murray's "Guide to Madras, 1886," still gives the measure of 64 gallons or one quarter, Imperial measure. In Bengal and Bombay, also, the Euboic talent of 1 bushel was recently in existence as the Man of 40 double pounds.

In Northern and Central India cubic measures have been in use, based on the double cubit cubed. The single cubit cubed, or charie, being the limit.

The Moslems in some parts of India added $\frac{1}{9}$ to the weight of rati, and in others they added $\frac{1}{9}$ to the pound or to the talent, increasing the 2,592 C.I. talent to 2,880 C.I., the talent of the Black cubit, so that much confusion has arisen under the Moslems.

The cadava of Utkala was a measure of capacity (Colebrooke's "Essay," p. 101). A cubit cubed of 7 palms (or 28 fingers a side) is spoken of, which apparently refers to the division of the Pyramid cubit. If, however, the bulk of the cubit cubed was increased by $\frac{1}{9}$ from 2,592 C.I., as seems probable, it would have given the talent, 2,880 C.I., of the Black cubit.

It seems probable that the cubic talent was divided by 10 on each side into 1,000 parts, so that the cadava was 2·88 C.I., or $\frac{1}{10}$ of the rotl of 7,200 O.G.T. With this decimal scale for the division of the talent there may also have been the binary division by 1,024.

The Man (Maund) and the Seer (Sir).

According to the Market system in India, the *Man* and the *Seer* vary in weight for every article sold, as well as in every market. But yet there is but one *standard* of weight in the bazaars, the British Indian man of 100 pounds Troy.

The Bazaar Standard.—A seer of 80 tolas (of 180 G.T.) equals 14,400 G.T., 40 seers giving a man of 100 pounds Troy. There are also local standards.

The seer is the common weight in use in the retail trade of India, but the weight varies in different parts, according to the source from which the local standards have been derived. In Northern and Central India the man weighs 40 seers, or 20 double seers. In parts of Southern India the man weighs 32 to 64 seers. The man of Northern India was originally one-sixty-fourth of the Pyramid double cubit cubed, or half a bushel. In Southern India the seer is also a measure of capacity; it is 8 palam of 10 varaha, equal in weight of water to 4,320 O.G.T., or 2,560 rati.

In Central India the original seer is two revised hon of 8,000 rati. Eighty Sataractica of 100 rati $= 2 \times 41\frac{1}{2}$ tolas of 96 rati, nearly. This may account (Kelly's "Cambist") for $41\frac{1}{2}$ rupees of 96 rati to a seer, equal to 4,000 (3,984) rati, the revised Euboic pound. Thus the Moslems have managed to preserve the ancient weights in part of India.

The local weights of India teem with connections with ancient weights, and the tables (pp. 105 and 114) show the variety of sources from which the standards are derived; yet it is only in the Malwa district that the old 16-ounce pound (of 6,912 O.G.T.) still prevails. The bases of the weights throughout India, except in the Aryan north-east portion, are the ganda weights—54, 216, 864 O.G.T.

The Rise in Weights, and the Dam of the Reign of Akbar.

The dam of the time of Akbar was a copper coin weighing 5 tanks or 1 tola, 8 mashas, and 7 ratis (Abùl Fayl, A.D. 1550). This, at 186 G.T. to the tola, gives to the dam a weight of 323·5 G.T. (say, 324 G.T.); but this is reckoning the dam at 167 rati, whereas it was, according to other computation, 160 rati or 5 tanks (see Table XXXVII.).

There is clearly a discrepancy in the various descriptions of the dam, and the only solution of the difficulty to my mind is that the dam was originally 324 G.T., a *paisa* or free weight brought from Bactria; and that with the early weights of Akbar

it was 167 rati of 1·9375 G.T., but that when Akbar raised his weights to the Attic standard it took its place as 160 rati of 2·025 G.T., or 5 tanks of 64·8 G.T. (the Attic drachma).

A few years ago a Bactrian gold coin of Eukratides (185 B.C.), of the weight of 2593·5 G.T. (2,592 G.T.) was discovered, being $\frac{1}{150}$ of the Attic talent of 388,800 G.T. It may, therefore, be assumed that the Moghuls brought with them from Bactria the *paisa* of 324 G.T., called a Dam, which is $\frac{1}{1200}$ of the Attic talent.

In Table XXXVII. (p. 114) the following changes in weights are shown :

Column.

I. The original standard of the Hindus, p. 4. The rati in use.

II. The original standard raised by Moslems 9 : 10. A raised rati in use.

III. The original standard raised by Moslems 9 : 10, and adopted by British 1808.

IV. The Moslem rendering of original Hindu standard as 22 : 28. Grain Troy in use.

V. Weights raised as 28 : 31 in reign of Shir Shah. Raised rati in use.

VI. Weights raised again to the standard of Attic talent in time of Akbar. Raised rati in use.

VII. Weights raised again at an uncertain period, from record of Indian weights and measures. Late Moslem standard.

The following are the principal systems of weights and measures found in India :

1. In Madras is the unit weight of 80 puranas (2,560 rati), half a pint or a gill (see Revised Euboic, Table II., p. 16); 800 of these (8 cubic feet of water) go to a Madras catty. This catty is also found raised as 9 : 10.

2. In Central India is the revised Hon of 6,750 O.G.T., and in some parts 7,000 G.T. ; 800 of these go to a catty.

3. The Moslem Arabic rotl of 7,200 O.G.T, is also found in Central India ; 800 of these go to a catty of 1,000 pounds Troy.

4. In Bombay the Roman pound (5,184 O.G.T.) of 80 dinars or Attic drachmas was recently in use.

5. The pounds of Shir Shah and Akbar are founded on the Roman pound.

6. The bushel measures of (64) and (80) systems are found all over India. (Table I., p. 14).

The Weight of the Catty—Commercial Weight of India.

1. Central India and Madras, 500 pounds Avoirdupois (nearly).

2. Bengal and Bombay, 500 pounds Avoirdupois and 1,600 pounds Avoirdupois.

All other weights are respectively multiples of the Roman, Attic, and Troy pounds, and Arabic rotl of 7,200 G.T.

(1.) A and B, 500 pounds Avoirdupois.

(1.) A. Central India. Ganda reckoning.

The catty = $(4)^6$ × the old ounce, 512 rati.
„ = 4,096 × 512 rati.
„ = 400 × 5,120 rati (the pint).
„ = 800 × { 2,560 rati (the half pint). / the seer.
„ = 500 pounds Avoirdupois (nearly).

(1.) B. Madras. Pagoda reckoning (Aryan).

The catty or candy = 64,000 varaha (32 rati).
„ = 800 × 80 varaha.
„ = 800 × { 2,560 rati. / the seer.
„ = 500 pounds Avoirdupois (nearly).

20 mans to a catty; therefore, the man of 25·0 pounds Avoirdupois = 20 pints = 3,200 varaha.

(2.) 1,600 pounds Avoirdupois (also 800 pounds and 3,200 pounds avoirdupois).

Bombay and Bengal.

The catty = $(40)^3$ × 100 rati (the Sataractica or tanka).
„ = 64,000 × { 100 rati, / or 168·75 G.T. standard, / or 175·00 G.T. Moslem standard.
„ = 1,600 × 4,000 rati (or 6,750 G.T. standard, or 7,000 G.T. Moslem).
„ = 1,600 pounds Avoirdupois, or Moslem pounds or hons.

The man in this case = 3,200 tankas of 168·75, or 175 G.T.

TABLE XXXVII.

Changes in the Weight of the Rati under Moslem Influences

Name.	Number of Rati.	Grains Troy. I. Original Hindu Standard.	II. Raised by Moslems.	III. Adopted by British 1821.	IV. Original Moslem Standard.	V. Raised Reign of Shir Shah.	VI. Raised Reign of Akbar.	VII. Raised after Akbar.	Name.
		[9 10]			[28 31]	[31 32·4]	[32·4 36]		
Rati	1	1·6875	1·875	1·875	1·75	1·9375	2·025	2·25	Rati.
Masha	8	13·5	15·0	15·0	14·0	15·5	16·2	18·0	Masha.
Purana. Tank ...	32	54·0	—	—	56·0	62·0	64·8	72·0	Tank.
Tola (Moslem) ...	96	162·0 ?	180·0	180·0	168·0	186·0	194·4	216·0	Tola.
Sataractica. Tanka ...	100	168·75	—	—	175·0	193·75	202·5	225·0	Tanka.
Karsha (double) ...	160	270·0	—	—	280·0	310·0	324·0	360·0	Dam.
	1,280	—	—	—	2240·0	2480·0	2592·0	2880·0	—
	4,800	—	—	—	—	—	9720·0	10800·0	Seer.
	192,000	—	—	—	—	—	388800·0 Attic talent	432000·0 Cubic foot	Man.

From these cases we may derive the inference that the man in India is 3,200 units of weight, and the following table will show that this is so:

MAN.

Man.	G.T.		G.T.	
=3,200	× 54	(varaha)	172,800 Bombay	25 old Hon, or 20 pints.
= ,,	×168·75	(Hindu tanka)	540,000 Central India	80 revised Hon, Euboic bushel.
= ,,	×175·0	(Moslem tanka)	560,000 Central India	80 lb. av. or Moslem.
= ,,	× 64·8	(dinar)	207,360 Bombay	40 Roman lb. of 5,184 G.T.
= ,,	×121·5	($\frac{1}{80}$ Akbar pound)	388,800 Attic talent	40 Akbar lb. of 9,720 G.T.
= ,,	×180	(rupee)	576,000 100 lb. Troy	80 miscal lb. of 7,200 G.T. Adopted British India weight.
= ,,	× 72	(miscal)	230,400 Shir Shah	40 Troy lb. of 5,760 G.T.
= ,,	×288	(2 ticals)	921,600 used in China, etc.	160 Troy lb. of 5,760 G.T.
= ,,	×225	(Bengal tola)	720,000 Black cubit talent	100 rotls of 7,200 G.T.

SEER.

The seer for gold and silver weight in India (except in parts of Bengal) is about 2,560 rati, or 4,320 G.T.

The following are instances (from Kelly):

	G.T.
Bangalore, Mysore. 80 Bahadry pagodas	4,227
Madura, S. Carnatic. 80 pagodas ...	4,480
Bellary, Ceded territory. 24 rupees ...	4,230
Masulipatam, N. Ciccars. 24 tolas ...	4,296
Palamcottah, S. Carnatic	4,551
Seringapatam, Mysore. 24 sutt. rupees ...	4,248
Ahmednuggur, Bombay. 24 tolas ...	4,521
Trichinopoly	4,167
Poonah, Dekkan. 24 tolas	4,600
Bombay. 24 tolas	4,238
Mangalore. 24 tolas	4,288
Pondicherry. 24$\frac{3}{8}$ tolas	4,293
Average	4,344
Standard, 80 pagodas at 54 G.T., or 24 tolas at 180 G.T.	4,320

WEIGHTS OF VARIOUS TOLAS (96 RATI) (from Kelly).

Bombay	178
Aurungabanda	179
Scindy, Malabar	179
Masulipatam	179
Ballary	176
Jaulnah, Nizam	184
Surat	186
Ahmadnuggur, Bombay	188
Malwa	190
Poona, Dekkan	191
Ahmedabad	193
Average	184

EXAMPLES.

Bangalore, Madras (Gold and Silver).

	Proposed G.T.	Kelly. G.T.
Fanam...	6	5·87
Pagoda	54	52·8
Adporde	540	528·3
Seer	4,320	4227·0

Bellary, Ceded Territory (Gold and Silver).

		Proposed Standard G.T.	Kelly G.T.
1	Canteroy fanam ...	6	5·875
2·5	Mass	15	14·687
9	Bahadry pagoda ...	54	52·875
30	Thollam	180	176·25
720	Seer	4,320	4230·0

Southern System, "Pathan Kings," p. 224.

1. Gunga, or rati.
2. Dugala.
4. Chavala, panam, fanam.
8. Dharana.
16. Hona, pratapa, mada.
32. Varaha, hun, or pagoda.

MADRAS.

Both in liquid and corn, and in commercial measures, the Moslem increase of $\frac{1}{9}$ holds good, added on to the ancient Hindu measures in many cases. This can be clearly seen in commercial measures. The liquid and corn measures are old cylindrical measures, the heights and diameters of which have probably been increased.

In Madras the old standard for the seer is 4,320 G.T. for gold and silver and commercial weights. The candy is 800 seers of 4,375 G.T. In Malabar the vis of 5 seers weighs 21,080 G.T. Amongst Moslems the seer reaches 4,480 G.T.

Madras and Malabar Weights.

Commercial Maund weighs { 175,000 G.T. (Kelly).
168.600 „ „

		Proposed Standard. G.T.	Moslem. G.T.
—	Varaha ...	54	56
—	Pollam ...	540	560
—	1 Seer ..	4,320	4,480
—	5 Vis ...	21,600	22,400
Old Hon	40 Maund ...	172,800	179,200
500	800 Candy ...	3,456,000	3,584,000
10,000	16,000 Garce ...	69,120,000	71,680,000

Cylindric Measures.

	Proposed Standard. G.T.	Moslem. Corn and Liquid.	Depth and Diameter Inside, in Inches.
Ollock	2,700	2,800	—
Puddy	21,600	22,400	5·038
Marcal	172,800	179,000	10·0616
Parah	864,000	896,200	—
Candy	3,456,000	3,584,000	17·205
Garce	69,120,000	71,680,000	—

Marcal = 750 C.I.
Candy = 64 gallons for milk.
Garce = { 16½ English quarters nearly.
9257½ pounds Avoirdupois.

This candy is given as 64 gallons, or one quarter, but it only appears to measure 51·2 gallons, or 512 revised Hons, or 8 cubic feet. It is probably a very ancient measure. (See page 8.)

Northern Ciccars.

Candy, 250 gallons (Kelly).

Grain Measure (Masulipatam).

		G.T.	
—	Arsolah ...	4,500	—
—	Solah ...	9,000	—
—	Zavah, Seer ...	18,000	—
—	Mannica ...	36,000	—
1	Marcal ...	216,000	—
80	Candy ...	17,280,000	250 gallons.
400	Garce ...	86,400,000	10,000 pints.

Bangalore.

Garce, 90 hundredweight = 70,560,000 G.T. (Kelly).

Grain Measure (see Madras Commercial).

	G.T.	
Chattack ...	900	—
Powe ...	3,600	—
Seer ...	14,400	—
Bullah ...	28,800	—
Colagah ...	115,200	—
Marcal ...	172,800	—
Candy ...	2,304,000	—
Garce ...	69,120,000	10,000 old Hon.

The lower values in these tables are Moslem. The upper values indicate the influence of Northern races, using the old Hon and pint.

BOMBAY PRESIDENCY.

Bombay Commercial Weight.

Candy equals 560 pounds Avoirdupois = 3,920,000 G.T. (Kelly).

	Original— G.T. [9 10]	Raised by Moslems. G.T.
Pice ...	144	160
1 Seer ...	4,320	4,800
40 Maund ...	172,800	192,000
800 Candy ...	3,456,000	3,840,000

Ahmednuggur Gold and Silver Weight.

Seer equals 4521·6 G.T.

	Pathans (Early). G.T.	Akbar. G.T.
1 Gonje ...	1·875	1·9375
8 Massa ...	15·0	15·5
96 Tola ...	180·0	186·0
24 Seer ...	4320·0	4464·0

Dry Measure, Bombay.

Maund equals 28 pounds Avoirdupois = 196,000 G.T.

∴ Candy equals 3,920,000 G.T.

		Original— Rati.	G.T. [9 10]	Raised $\frac{1}{9}$ by Moslems. G.T.
—	Tipree ...	2,000	3,375	3,750
1	Seer ...	4,000	6,750	7,500
4	Adowla	16,000	27,000	30,000
64	Parah	256,000	432,000	480,000
512	Candy ...	2,048,000	3,456,000	3,840,000

Measure for Rice or Batty, Bombay.

Morah = 25 Winchester bushels = 13,500,000 G.T.

(Kelly states that a candy equals the above—probably an error.)

		Proposed Original—		With 15 Tipree to Adowla.
		Rati.	G.T.	G.T.
—	Tipree ...	1,000	1687·5	Moslem 1,800
1	Seer ...	2,000	3,375	„ 3,600
8	Adowla	16,000	27,000	27,000
160	Parah ...	320,000	540,000	540,000
1,024 / 1,000	Candy ...	2,000,000	3,456,000 / 3,375,000	3,456,000 / 3,375,000
4,096 / 4,000	Morah ...	8,000,000	13,500,000	13,500,000

This latter table of weights adheres to the original rati system, except that 15 tiprees go to the adowla instead of 16, in order to make the lower weights accord with the rupee. Evidently the grain Troy has been used.

The original tipree is evidently 10 sataractica.

BOMBAY.

Measures of Capacity.

5 Quarters, or 40 Bushel Measure.

In the Province of Aurungabad, Bombay, there are several cities where (1827) there are seers of $2\frac{1}{2}$ pounds Avoirdupois, 64 seers to a man, and 20 mans to a candy. In others the seers are $\frac{10}{3}$ or $\frac{5}{3}$ pounds Avoirdupois, with 48 or 96 seers to a man. The candy is 3,200 pounds Avoirdupois, equal to 5 quarters or 40 bushels.

Bombay.

Man.		Pounds.	Seer.		Pounds.		Pounds.	
20	Candy	3,200	64	Man	160 0 0	Seer	2 8 0	Standard.
,,	,,	2,996	,,	,,	149 12 12	,,	2 5 7	Chanadore.
,,	,,	3,152	,,	,,	157 10 0	,,	2 7 6	Dindore.
,,	,,	2,952	,,	,,	147 10 0	,,	2 4 14	Jamkhair.
,,	,,	3,265	,,	,,	163 4 0	,,	2 8 13	Palloda.
,,	,,	3,217	,,	,,	160 13 2	,,	2 8 3½	Roombharee.
,,	,,	—	80	,,	—	,,	2 0 0	—
,,	,,	3,200	96	,,	160 0 0	,,	1 10 6	Standard.
,,	,,	6,400	96	Koora	320 0 0	,,	3 4 0½	Belgaum.
,,	,,	1,920	48	Maund	96 0 0	,,	1 15 8½	Poona.
		2,560	64	,,	128 0 0	,,	—	
		2,880	48	,,	144 0 0	,,	3 0 0	

BENGAL AND CENTRAL INDIA.

The values of the seers differ over 3 per cent., and as the rotl of 7,200 G.T. and pound Avoirdupois of 7,000 G.T. differ to that amount, it is not easy to determine to what they belong, seeing that both pounds are Moslem. The weights seem to run generally 20 seer to a maund, giving either 40 pounds Avoirdupois, or 40 rotl, equal to 50 pounds Troy.

Nizam's Country.

16 Chattaeks ...	Maund (40 seer)	Seer	1 15 8	Ahmednuggur	
,, ,, ...	,, ,,	,,	1 15 12	Hydrabad.	
,, ,, ...	,, ,,	,,	2 0 1	Jaulnah.	
,, ,, ...	,, ,,	,,	2 0 1	Sekundrabad.	

Malwa (Bengal).

Rupees.					
84 Salim Shye	Maund (20 seer)	Maunee (12 maunds)	Seer 2 0 6	Malwa.	
80 Bhopal ...	—	,, (260 seer)	,, 1 14 13	Bhopal.	
,, ,, ...	,, (48 seer)	,, (180 seer)	,, 1 14 10	Bhelsa.	
82 Ougien ...	,, (20 seer)	,, (12 maunds)	,, 2 0 6¾	Indore.	
80 Ankosee ...	—	—	,, 1 15 8½	Katee.	
80 Ougien ...	,, (20 seer)	,, (12 maunds)	,, 1 15 10	Nolye.	
92 Salim Shye	Maund (15 seer)	Maunee (12 maunds)	Seer 2 3 7¾	Mundissor.	
80 Ougien ...	,, (16⅞ seer)	,, (12 maunds)	,, 1 15 10	Ougein.	
80 Salim Shye	,, (20 seer)	,, (12 maunds)	,, 1 14 13½	Pertabghur.	
81 ,,	,, (28 seer)	,, (18 maunds)	,, 1 15 3½	Omutwarra.	

Bombay.

Rupees.				
80 Ankosee ...	Maund (48 seer)	Candy (20 maunds)	Seer 1 15 8	Poona.
80 ,, ...	,, (64 seer)	,, (20 maunds)	,, 1 15 8	Jamkhair.
80 Bhopal ...	,, (40 seer)	Maunee (4 maunds)	,, 1 14 13	Bairsuah.

I suggest that this seer of two old Hon, or 8,192 rati, divided into 18 chattack of 512 rati each, was the old primitive measure of the people of Bengal, and that the 20 seers to the maund was the simple multiple by which a Northern intruding race introduced a unit of half a bushel. Twenty maunds of 8,192 rati equal 16 quarts of 10,240 rati, or half a bushel.

Bengal and Calcutta Weights and Measures: Gold and Silver.

Calcutta.

⅓ Rati.		G.T.
1	Dhan	0·5625
32	Massa	18
320	Sicca rupee ...	180
384	(Shekel)	216
400	Tola	225
32 × 400	Rotl	7,200

Kelly gives 224·58 G.T. per tola.

I doubt whether there was ever any ancient gold and silver weight of Eastern Bengal; these weights are probably of recent origin.

The gold and silver weights of Malwa and Surat appear to follow another Moslem system, 56 G.T. to the purana raised as 28 : 31, or to 62, giving a rati of 1·9375 G.T.

Rati.		Surat. Estimated.	Surat. G.T.	Malwa. G.T.	Poona. G.T.	Ahmed-nuggur. G.T.	Jaulnah. G.T.
1	Rati ...	1·9375	1·95	1·979	1·995	1·95	1·92
3	Val ...	5·8125	5·85	—	—	—	—
8	Massa ...	15·5	15·6	15·820	15·97	15·7	15·375
96	Tola ...	186·0	187·2	190·0	191·0	188·4	184·5
35×96	Seer ...	6510·0	6552·0	—	4600·0	4521·0	14027·0

An examination of these weights will show that up to the tola they follow Column V., Table XXXVII., of the weights of

Akbar, but vary in the multiples of the tola. Poona and Ahmednuggur incline to the 4,320 G.T.

BENGAL.

Grain. Pallie $9\frac{1}{12}$ U. Av. (Kelly).

			Possible. G.T.	Probable. G.T.
	1	Chattack ...	900	810
	5	Koonke ...	4,500	4,050
	20	Raik ...	18,000	16,200
1	80	Pallie ...	72,000	64,800
8	—	Maund ...	576,000	518,400
20	—	Soallee ...	1,440,000	—
320	—	Khahoun ...	23,040,000	—

Kelly gives the pallie at 63,583 G.T. Two suggestions are given for this weight.

Liquid.

		G.T.	Kelly.
1	Chattack ...	900	5 Sicca rupees
4	Pouah ...	3,600	—
16	Seer ...	14,400	—
64	—	57,600	—
640	Maund ...	576,000	—

This weight agrees with Kelly's record, and can be used as a standard for the grain weight, wheat and barley $\frac{1}{5}$ lighter.

Commercial.

			G.T.
—	—	Sicca	180
—	5	Chattack	900
1	80	Seer	14,400
40	—	Maund	576,000

Kelly gives the seer at 14436.0 G.T.

The foregoing three tables appear to be ancient. The maund, originally a bushel of 540,000 G.T., raised at some period as 15 : 16 to 576,000 G.T.

The following table gives the recorded scales of weights during late Moslem (Moghul) period. Value of rati is not given, and 1·9375 G.T. is proposed, as it gives nearly 100,000 G.T. to a man. ("Babar's Memoirs," p. 332, A.D. 1526; "Pathan Kings," p. 222.)

Grains Troy. "Numismata Orientalia." G.T.	Rati.	
1·9375	1	This value for the rati in Shir Shah's and Akbar's time is given in "Pathan Kings," p. 409.
15·5	8	Masha.
62·0	32	Tang (tank).
77·5	40	Miscal.
186·0	96	Tola.
{2604·0 {2500·0	96 × 14	Seer 10 C.I. Half the Bosphorous pound.
100,000	96 × 14 × 40	Man 400 C.I.
1,200,000	12 Man =	Mani 4,800 C.I.
10,000,000	100 Man =	Mani 40,000 C.I.

Later Indian and Foreign Weights.

From the Haft Kulzum, "Pathan Kings," p. 223, note.

The habbat is assumed to be the Troy grain in this case.

Possible O.G.T.	Habbats.	
	1	Habbat (a grain).
	4	Kerat. Carob (keration).
	8	Tang.
	48	Dirham. (This is the value of the deirham in Troy grains).
69·12	68	Miscal. (This miscal runs 90 to the pound instead of 96).
311·04	306	Astar (4½ miscals).
518·4	510	Ounce (7½ miscals). Probably 518·4 ($\frac{1}{10}$ Roman and Bactrian pound).
6220·8	6,120	Rotl (pound). The nearest Moslem pound is the 6220·8 Irak pound.
	12,240	Man.
	22,950	Kailajat.

Linear Measure.

The only units of length likely to have been in use in India in early times are the cubit of a man (about 17·66 inches), and the geometric cubit of 19·75 inches. The Indian weights do not indicate any other cubit until after the invasion of Alexander the Great.

The rude stone monuments (Chapter IV.) and the caves of Elora show that there is a probability of the rude stone builders having brought in a cubit connected with 18 inches. The Moslems probably brought in Persian and Babylonian units, certainly the Black cubit.

The old systems will be found to prevail in many parts of India (pp. 21-24 and Table IV.). The name "hasta" (hath) is still used for the cubit, which is now divided into 24 anguls (digits), giving 96 to the fathom; but General Cunningham ("Ancient Geography of India," p. 575), states that in early times there were 25 anguls to the cubit. If so, the old hasta may have been the ancient geometric cubit of 19·75 inches, with the ·79012 inch digit, giving a Moslem hasta (of 24 anguls) of 18·96288 inches. In many parts of India the hasta is about 19 inches.

The hasta has been estimated by various authorities from 17·3 to over 20 inches, and the results are so inconsistent that it seems probable that the cubits 17·66, 18, and 19·75 inches have been taken together as one.

We may learn something from the length of the Moslem gaz (as regulated by Moslem rulers in the sixteenth century). The coin Sikandar Lodi was a Moslem digit in diameter, and there were $41\frac{1}{2}$ to a gaz. After careful measurements of these coins in recent years this gaz is computed to be almost exactly 30 inches, giving a digit of 0·723 inch. This, at 24 digits to the hasta, gives a cubit of 17·352 inches for that period ("Pathan Kings," p. 372); and at 25 digits to a cubit, 18·075 inches. Several authorities assume the hasta to have been 18 inches.

The Moslems were apt to combine the use of old weights, weaving them into incongruous systems, and it is suggested that the $41\frac{1}{2}$ digits of the gaz is only a means to an end— $41\frac{1}{2} \times 60 = 2{,}490 = 2{,}500$ (nearly). This gaz of 30 inches may

be $\frac{1}{60}$ of the Persian gareeb, one quarter of the Babylonian stade of 10,000 digits of 0·7275 inch, ten stades to a minute of arc (see p. 50).

			Digit.	Inch.
Digit	—	—	1	Greek digit, 0·7275
—	$1\frac{1}{2}$	1	$41\frac{1}{2}$	30·352
Gareeb ...	90	60	2,500	1818·75
Babylonian stade	360	240	10,000	7275·0

This is merely given as a possible solution. It seems a safer plan to take a longer measure than the width of 42 coins, however carefully they were measured.

It has been mentioned that the cos or league of 2,000 fathoms existed in India, 10,000 cos to the circumference of the earth, giving a digit of 0·79012 inch (pp. 21-23).

Now, it is laid down in the Ayin-i-Akbari (*c.* A.D. 1594) that the cos contains 100 cords of 50 gaz, or 400 ban of $12\frac{1}{2}$ gaz, giving 5,000 gaz to a cos, the gaz being $41\frac{1}{2}$ Moslem digits.

By substituting 24 anguls of 0·79012 inch instead of 25 to of the hasta, we get a recent Moslem cos of 151703·04 inches in the following table :

	Inch.	
1 angul	0·79012	—
24 anguls = 1 hasta	18·96288	—
25 „ = 1 cubit	19·753	—
4 hastas = 1 danda	75·85152	Fathom
10 hastas = 1 ban	189·6288	—
2,000 dandas = 1 cos	151703·04	—

This gives a gaz 30·34 inches, as compared with 30 inches from the Sikandar Lodi coins, and a digit of 0·73 inch. General Cunningham makes the digit 0·72976 inch ("Pathan Kings," p. 372).

CHAPTER VI

COMPARISON OF WEIGHTS AND MEASURES GIVEN BY THE PRINCIPAL AUTHORITIES WITH THE STANDARDS DERIVED FROM THE DOUBLE CUBIT CUBED

Weights.

All principal authorities agree generally in the proportions of the various talents one to another, but no solution has as yet been given for the many discrepancies which exist between the various systems and weights put forward, differing as much as 8 per cent. It is proposed in this chapter to show how the discrepancies have occurred in weights which must all have been derived from the double cubit cubed.

Sources from which Weights have been Derived.

There are only four sources:

(1) The original cubic foot of 1,769·472 C.I. and 1,728 C.I.
(2) The Euboic bushel of 2,211·84 C.I. and 2,160 C.I. and $\frac{3}{4}$.
(3) The Eginetan cubic foot of 2,592 C.I. and $\frac{3}{4}$.
„ The Attic cubic foot of 3,888 C.I. and $\frac{3}{4}$, derived from Eginetan.
(4) The Gudean talent (late) of 1,800 C.I.
„ The Black Cubit cubed of 2,880 C.I., derived from the Gudean talent.

From the above the following minas are derived, given in Table XL. in the same order. The mina of $\frac{1}{60 \cdot 5}$ talent is due to Roman reduction of minas from 100 to 96 drachmas.

TABLE XXXVIII.

Old Grains Troy.

Original Talents.	Proportion.	$\frac{1}{6\,0\,4}$ Robertson.	$\frac{1}{6\,0\,0}$	$\frac{1}{6\,0\,2\cdot5}$ Petrie. Hultsch.	$\frac{1}{8\,0\,0}$	$\frac{1}{1\,0\,0\,0}$
432,000	80	6,750	7,200	6,912	5,400	4,320
540,000	100	8437·5	9,000	8,640	6,750	5,400
405,000	75	6328·125	6,750	6,480	5062·5	4,050
648,000	120	10,125	10,800	10,368	8,100	6,480
486,000	90	7593·75	8,100	7,776	6,075	4,860
388,800	72	6,075	6,480	6,220·8	4,860	3,888
291,600	54	4556·25	4,860	4,665·6	3,645	2,916
450,000	$\frac{2\,5\,0}{3}$	7031·25	7,500	7,200	5,625	4,500
720,000	$\frac{4\,0\,0}{3}$	11250·0	12,000	11,520	9,000	7,200

The minas in the column under $\frac{1}{6\,0\,4}$ are those quoted by Robertson, whilst those under $\frac{1}{6\,0\,2\cdot5}$ are those quoted by Hultsch and Petrie ("Encyclopædia Britannica").

There are also two other sets of minas derived directly from the double cubit cubed—viz.:

6998·4 O.G.T. $\frac{1}{2\,5\,0\,0}$ 69,984 C.I.
7000·0 O.G.T. $\frac{1}{2\,5\,0\,0}$ 70,000 C.I. } giving $\frac{5}{6}$ pint.

Table XXXIX. shows that the original minas are the pint and portions of pint measures quoted by Robertson. It is not clear how he arrived at them, for he only calls them *approximate standards*, whereas they are absolutely correct, as can be seen from their derivation from the pint of 5,000 rati. The minas quoted by Hultsch and Petrie are not older than the Roman Empire, unless the Romans took their reduction of $\frac{9\,6}{1\,0\,0\,0}$ of a mina from the East.

The minas deduced from dividing the double cubit cubed by 2,500 may have any age assigned to them, but they probably came in with the Black cubit. The 7,000 G.T. mina is found in India, and is our Avoirdupois pound, but there is no record of any early origin to it. See Articles "Money—Weights and Measures," by Professor Kennedy, and "Babylonia," by Professor Hommel, Hastings' "Dictionary of the Bible."

TABLE XXXIX.

SIX VARIETIES OF THE FOUR PRINCIPAL TALENTS OF LATER TIMES, DERIVED FROM THE ORIGINAL TALENTS, BASED ON 5,000 RATI THE MINA.

Old Grains Troy.								Ancient Barley.	Rati.		
Proportion.		Gudean.	$\frac{96}{100}$ Old.	$\frac{1}{1500}$ 69,984 C.I.	$\frac{1}{1500}$ 70,000 C.I.		Euboic Pints.				
			Petrie. Hultsch.	Deduced.	Kennedy. Hommel.		Robertson.	Barley used Later.	Rati in Use Early.		
5·4	90	450,000	466,560	453496·32	453,600	—	455,625 [9]	405,000 [8]	270,000 [3 2]	—	$\frac{3}{4}$ Eginetan.
		7,500	7,776	7558·272	7,560	—	7593·75	6,750	4,500	$\frac{9}{10}$ pint	Light Babylonian.
		125	129·6	125·9712	126	—	126·514	112·5	75	—	Irack.
4·5	75	375,000	388,800	377913·6	378,000	379,000	379687·5	337,500	225,000	—	$\frac{3}{4}$ Euboic.
		6,250	6,480	6298·56	6,300	6,315	6328·125	5,625	3,750	$\frac{3}{4}$ pint	Gold, Babylonian.
		125	129·6	125·9712	126	$126\frac{1}{3}$	126·562	112·5	75	—	—
6	100	500,000	518,400	503884·8	504,000	—	506,250	450,000	300,000	—	Euboic Standard.
		8333·3	8,640	8398·08	8,400	—	8437·5	7,500	5,000	1 pint	Silver, Babylonian.
		166·6	172·8	167·9616	168	—	168·75	150	100	—	—
4	66·6	—	345,600	335923·2	336,000	336,750	337,500	300,000	—	—	Silver. Late.
		—	5,760	5598·72	5,600	5,660	5,625	5,000	—	$\frac{2}{3}$ pint	Phœnician.
		—	115·2	—	112	$11\frac{1}{3}$	112·5	100	—	—	—
5	83·3	—	432,000	419,904	420,000	—	421,875	375,000	—	—	Egyptian. Late.
		—	7,200	6998·4	7,000	—	7030·5	6,250	—	$\frac{5}{6}$ pint	Olympic.
		—	(Kat) 144	139·968	140	—	140·625	125	—	—	—

NOTE —This table only shows talents of 60 minas, or 3,000 double drachmas, because the later division of the talent was into 60 minas. The earlier multiple for the old talent was 80, and in some cases still earlier 64, so that the Euboic or pint talent was originally 400,000 rati, and, still earlier, 320,000 rati.

TABLE XL.

Showing the Four Varieties of Minas connected with Each Old Talent.

O.G.T.						Barley, Ancient.	Rati.	H = Hultsch.		Names Given by Experts.
Silver Pound. 5,400	Shekel.	Old Talent.	Mina.	Roman Talent.	Mina.					
120	216	648,000	10,800	622,080	10,368	—	—	—	—	—
Eginetan ...	—	—	—	—	10,125	9,000	6,000	Robertson, H.	$\frac{6}{5}$ pint	Eginetan Islands, Sicily.
—	—	—	—	—	5,184	4,500	3,000	Hultsch	—	—
100	180	540,000	9,000	518,400	8640·0	—	—	Petrie (8,600) Hultsch (O.G.T.)	pint	Babylonian silver mina
Euboic ...	—	—	—	—	8437·5	7,500	5,000	Robertson, H.	—	Persian silver
—	—	—	—	—	8400·0	—	—	Kennedy	—	Babylonian silver
—	—	—	—	—	8398·08	—	—	—	—	—
72	129·6	388,800	6,480	373,248	6220·8	—	—	Hultsch	—	—
Attic ...	—	—	—	—	6075·0	5,400	3,600	Robertson	$\frac{18}{25}$ pint	Roman, Attic
—	—	—	—	—	3110·4	—	—	Hultsch	—	—
80	144	432,000	7,200	414,720	6,912 [512	—	—	—	—	—
Cubic foot...	—	—	—	405,000	6,750 [500	6,000	4,000	Petrie (6,700) (O.G.T.) Robertson, H.	$\frac{4}{5}$ pint (pound)	Attic silver.
—	—	—	—	—	6,720	—	—	—	—	—
—	—	—	—	—	6718·46	—	—	—	—	—
90	162	486,000	8,100	466,560	7776·0	—	—	Petrie Hultsch	—	Babylonian light trade
—	—	—	—	455,625	7593·75	6,750	4,500	Robertson	$\frac{9}{10}$ pint	Ptolemaic
$\frac{3}{4}$ Eginetan	—	—	—	—	7580·0	—	—	—	—	—
—	—	—	—	—	7568·27	—	—	—	—	—

75	135	405,000	6,750	388,800	6480·0	—	—	Hultsch / Robertson	—	Babylonian gold mina
—	—	—	—	379657·5	6328·125	5,625	3,750	—	¾ pint	Persian gold
—	—	—	—	—	6300·0	—	—	Kennedy	—	Babylonian gold
¾ Euboic ...	—	—	—	—	6298·56	—	—	—	—	—
108 and 54	194·4	583,200	9,720	559,872	9331·2	—	—	Hultsch	—	—
—	—	—	—	546,750	9112·5	8,100	5,400	—	$\frac{27}{60}$ pint	—
¾ Attic ...	—	—	—	—	4556·25	—	—	Robertson	—	Syrian
Late Gudean: 133·3	240	720,000	12,000	691,200	11,520	—	—	Hultsch	—	Phœnician silver
Late Gudean: —	—	—	—	—	11,250	10,000	—	—	⅓ pint	—
Late Gudean: —	120	360,000	—	345,600	5,760	—	—	—	—	—
Late Gudean: —	—	—	—	—	5,625	5,000	—	—	⅔ pint	400,000 Ancient barley
Late Gudean: —	—	—	—	—	5,600	—	—	Petrie / Kennedy	—	Babylonian silver. Phœnician
Late Gudean: —	—	—	—	—	5598·72	—	—	—	—	—
Gudean: Phœnician, Olympic:	150	450,000	7,500	432,000	7,200	6,400	—	Petrie (14,600)	—	—
Gudean: Phœnician, Olympic: —	—	—	—	421,875	7031·25	6,250	—	—	⅚ pint	500,000 Ancient barley
Gudean: Phœnician, Olympic: —	—	—	—	420,000	7,000	—	—	Kennedy	—	Egypt. Avoirdupois pound
Gudean: Phœnician, Olympic: —	—	—	—	—	6998·4	6220·8	—	—	—	—
64 Troy	115·2	345,600	5,760	331,776	5529·6	—	—	—	—	—

The Hebrew Talent (see p. 47).

We have the following information :

Exodus : 3,000 shekels of 216 O.G.T. = talent 648,000. 2,592 C.I. Eginetan.

Epiphanius makes Hebrew talent = 125 Roman pounds = 648,000.

Coins of Maccabees, 3,000 shekels = 666,000. 2 per cent. too high.

Josephus makes Hebrew mina = $2\frac{1}{2}$ Roman pounds = 12,960 O.G.T. $12{,}960 \times 60$ = Talmud talent.

Ezekiel states "your maneh" :

- 20 shekels of 259·2 O.G.T. = $5{,}184 \times 75$ = 388,800 O.G.T.
- 25 shekels of 259·2 O.G.T. = $6{,}480 \times 60$ = 388,800 O.G.T.
- 15 shekels of 259·2 O.G.T. = $3{,}888 \times 100$ = 388,800 O.G.T.

We have thus two sets of talent—the Eginetan and Talmudic :

	Heavy Shekel.		Light Shekel.	
Before Roman Empire :				
Eginetan ...	648,000	216	324,000	108
After Roman Empire :				
Talmudic ...	777,600	259·2	388,800 (Attic)	129·6

The following table gives a probable solution :

	Talent. G.T.	$\frac{1}{64}$	$\frac{1}{60}$	$\frac{1}{50}$	Shekels. G.T.
Originally ...	648,000	10,125	10,800	12,960	216. 3,000 shekels to a mina
Captivity ...	640,000	10,000	—	12,800	—
Return ...	648,000	—	—	12,960	259·2. 2,500 shekels to a mina
	324,000			6,480 Attic mina	
$\frac{6}{5}$ of 648,000 G.T.	777,600	—	12,960	50 shekels	259·2. 3,000 shekels

The value of talent depends on whether 50 or 60 minas to a talent.

Volumes (Examples from the "Encyclopædia Britannica").

The variation in the principal measures of capacity in different countries given below can all be accounted for, and the deviation from standard is in no case more than 1 in 80.

Measures of Egypt and of Gythium (Southern Peloponnesus).

The Egyptian Apet or Besha, called by Petrie Theban measure, is $\frac{1}{60}$ of the Eginetan double cubit cubed (69,984 C.I.), and is 1166·4 C.I., or 4 gallons of 291·6 each. 144 pounds of 40·5 C.I. make the khar of 5,832 C.I.

The measure of Gythium is founded on the khar, reduced at a later period to $\frac{96}{100}$ of the Egyptian measures, as shown in table below :

TABLE XLI.

	Proportions.		Standard of Khar. Page 31.	Standard Reduced. 100 : 96.	Egypt.	Gythium.
Pounds ...	—	0·5	20·25	19·44	—	—
Egypt: *Hennu*	1	0·72	29·16	—	29·2	—
	—	1·0	40·5	38·88	—	—
	—	1·5	60·75	58·32	—	58·0
	4	—	116·64	—	116·8	—
	—	6·0	243·0	233·28	—	232·0
	—	24·0	972·0	933·12	—	932·0
Collathon Apet	40	28·8	1166·4	—	1168·0	—
	—	72·0	2916·0	2799·36	—	2796·0
	160	—	4665·6	—	4672·0	—
The Khar ...	—	144·0	5832·0	—	—	—
Great Theban	400	—	11664·0	11680·0	—	—

The following measures in Table XLII. are all on the Pyramid Coffer Standard :

(*a*) Hebrew System, stated to be the earliest, is $\frac{80}{81}$ of the standard : evidently the measure of the Captivity, 72 × 32 C.I. The Hebrew measures appear to me to be :

Volumes (C.I.)	2,592 and 1,296	2304	2332·8	1749·6	
Proportions	90 „ 45	80	81	54	
	Original.	Captivity.	Return.	Greek and Roman Period.	

(*b*) Phœnician, Carthaginian, and Syrian systems, are founded on 40·5 C.I., the old Eginetan pint, 54 of which make an artaba.

(*c*) Seleucidan, Babylonian, Persian, and Eginetan systems, are founded on the Black cubit talent of 2,880 C.I., or $\frac{5}{3}$ of the European cubic foot ; 2,400 C.I. to the artaba.

TABLE XLII.

Examples of Standards of Volume given in "Enyclopædia Britannica" compared with the Actual Standards.

All in C.I.

		Standard Eginetan.	Hebrew Euboie.	Phœnician; Carthaginian.	Syrian.		Standard Gudean. [9]	Raised. [10]	Seleucidan.	Babylonian.	Persian.	Eginetan.
Log. Xestes ...	1	32·4	32·0	—	—	—	30·0	33⅓	—	33	—	—
Syrian Xestes...	1¼	40·5	—	—	41·0	41·0	40·0	44·4	44·0	—	—	—
Capetis ...	2¼	72·9	—	—	—	—	67·5	75·0	—	—	74·4	—
Choenix	3	97·2	—	—	—	—	90·0	100·0	—	—	—	100
Kab ...	3¾	121·5	128·0	123	—	—	120·0	133·⅓	—	132	—	—
Chous ...	9	291·6	—	—	—	—	270·0	300·0	—	—	—	300
Hin ...	12	388·8	383·0	—	—	—	360·0	400·0	—	—	—	—
Hekteus Saton ...	22½	729·0	—	740·0	740·0	—	675·0	750·0	—	—	—	—
Hekteus	24	777·6	—	—	—	—	720·0	800·0	—	—	—	800
Collathon	33¾	1093·5	—	—	1110·0	—	—	—	—	—	—	—
Maris ...	56¼	1822·5	—	—	—	1850·0	—	—	—	—	—	—
Maris ...	60	1944·0	—	—	—	—	1800·0	2000·0	—	1,983	1,983	—
Bath ...	67½	2187·0	—	—	2220 0	—	—	—	—	—	—	—
Bath ...	72	2332·8	2300·0	—	—	—	2160·0	2400·0	—	2,380	—	—
Artaba ...	96	3110·4	—	—	—	—	2880·0	3200·0	—	—	—	3,200
Metretes	108	3499·2	—	—	—	—	3240·0	3600·8	—	—	3,570	—
Metretes	112½	3645·0	—	—	—	3700·0	—	—	—	—	—	—
Metretes	120	3888·0	—	—	—	—	3600·0	4000·0	4,000	—	—	—
Medimnus	144	4665·6	—	—	—	—	4320·0	4800·0	—	—	—	4,800
Kor. Homer ...	675	21870·0	—	22200·0	—	—	—	—	—	—	—	—
Kor. Homer ...	720	23328·0	23000·0	—	—	—	21600·0	24000·0	—	23,800	—	—
Achane ...	4,320	—	—	—	—	—	129600·0	144000·0	—	142,800	142,800	—

Greek and Roman Systems ("Encyclopædia Britannica").

A great number of examples are given by Petrie, which can be ranged into two series, in the proportion 15 : 16. The higher series is taken by turn, with the remark that it is uncertain.

It can be shown that both series are correct. The Attic or Occidental pound, 4,860 O.G.T., 48 to the amphora, is to the Roman pound as 15 : 16. The Roman amphora, 1555·2 C.I., is generally assumed as the standard of Roman volumes, but in later times no doubt the Roman pound, giving 1658·8 C.I., was also used. It will be seen that 100 Roman pounds of 2073·6 C.I. divided by 64 gives the sextarius of 32·4 C.I., and divided by 60 the raised sextarius of 34·56 C.I. The table below gives the Standard value and the raised value with the higher examples from "Encyclopædia Britannica":

TABLE XLIII.

		Standard		Roman.	Greek.
		Eginetan. [15]	Raised. [16]		
Cotyle	½	16·2	17·28	—	17·5
Pound	—	19·44	20·736	—	—
Xestes	1	32·4	34·56	34·4	—
Choenix ...	2	64·8	69·12	—	70·0
Congius Chous...	6	194·4	207·36	206·0	210·0
Modius Hekteus	16	518·4	532·96	—	560·0
Urna Hekteus ...	24	777·6	829·44	825·8	—
Amphora ...	48	1555·2	1658·8	1650·0	—
Metretes ...	72	2332·8	2488·32	—	2520·0
Medimnus ...	96	3110·4	3317·76	—	3360·0
Medimnus ...	144	4665·5	—	—	—

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